POWER PLANT ENGINEERING

Established Over 31 Years

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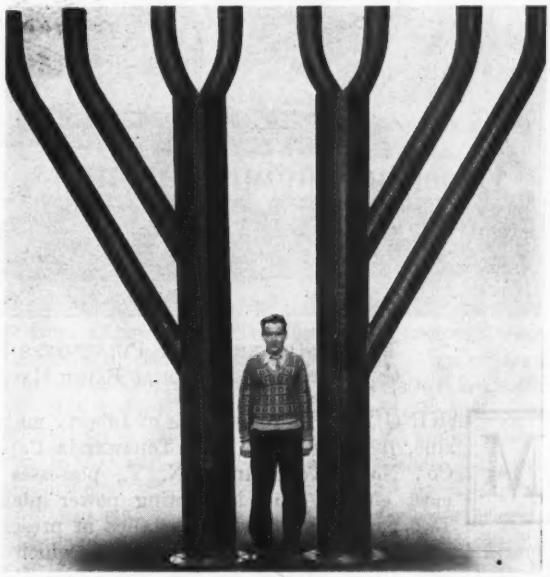


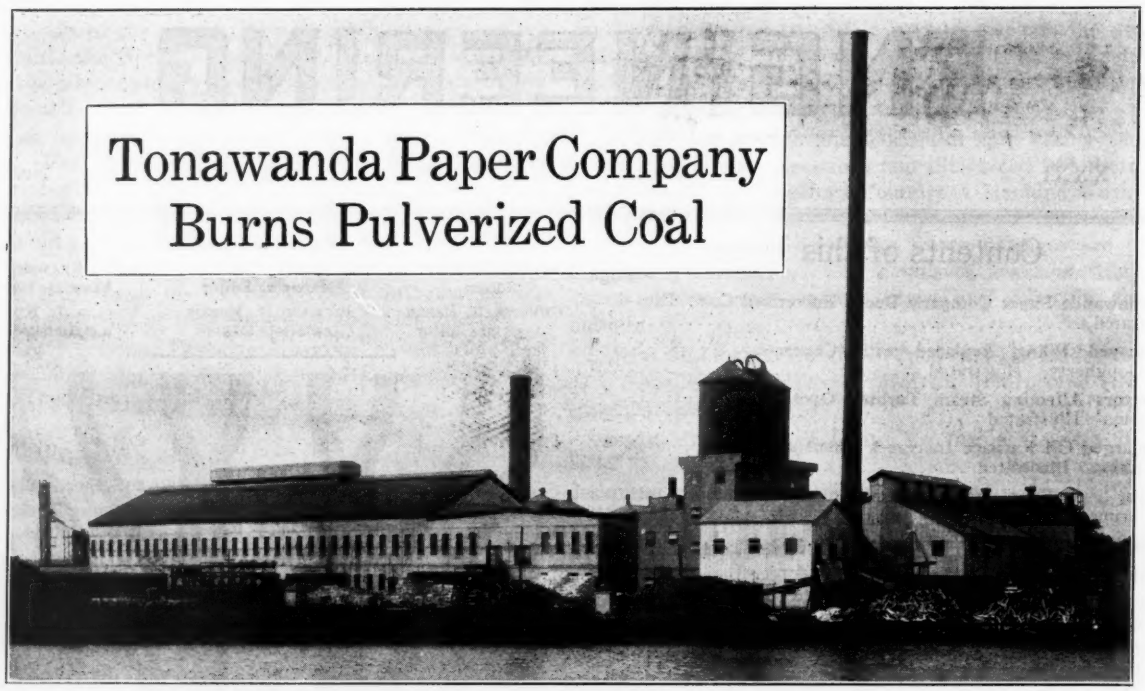
So Rested He by the Tumtum Tree

DO YOU REMEMBER the story of the Jabberwock? How this terrible creature with eyes of flame was slain as it came whiffing and burbling through the tulgey wood? How, just before he dispatched it with his vorpal sword, the hero of the story rested for a moment at the Tumtum Tree, "and stood awhile in thought"?

Ever since we first read of Alice's Adventures in Wonderland we have been curious about the Tumtum Tree. What was it like? Where could we find one? What was there about it that induced the brave youth to rest by it? But of no avail; all these years our curiosity remained unrewarded. It seemed that the Tumtum Tree was to remain, forever, a mystery.

Then, one day we ran across this picture and at once we recognized it as the Tumtum Tree in all its fantastic glory. The "Valve World," however, in which it first appeared, claims that it is a picture of two 14-in. wrought steel risers, made by Crane Co., each with four 6-in. bends welded in and that they are to be used as safety valve vents on boiler No. 22 at the Calumet Station in Chicago. It may be so, but we are reluctant to believe it. There must be an error somewhere, for surely this is the Tumtum Tree. And to prove it, there at the foot stands the brave youth that slew the Jabberwock—note the smile on his face. No, regardless of this theory of wrought steel headers to us this is going to remain the Tumtum Tree and nothing more.

Tonawanda Paper Company Burns Pulverized Coal



TURBINE-DRIVEN UNIT PULVERIZERS SERVE BOILERS SUPPLYING STEAM TO TURBO-GENERATORS ON SECTIONAL PAPER MACHINE DRIVE AND ALSO TO SODA MILL TURBINE

MAKING PAPER for the use of Liberty magazine, the new mill of the Tonawanda Paper Co., North Tonawanda, N. Y., possesses a most efficient and interesting power plant. Two paper machines are installed at present, motor-driven by the sectional drive system which is supplied with direct current by two turbo-generators located with their control boards in the basement under the machines they serve, their exhaust going to the driers. Alternating current for part of the paper machine room equipment and for lighting the mill is purchased from the public utility lines. In the soda mill is installed another turbo-generator set to supply alternating current and exhaust steam for the chemical process work; this unit also supplies alternating current to the lighting system and the paper machine room through an automatic throwover device, in case the purchased power should fail.

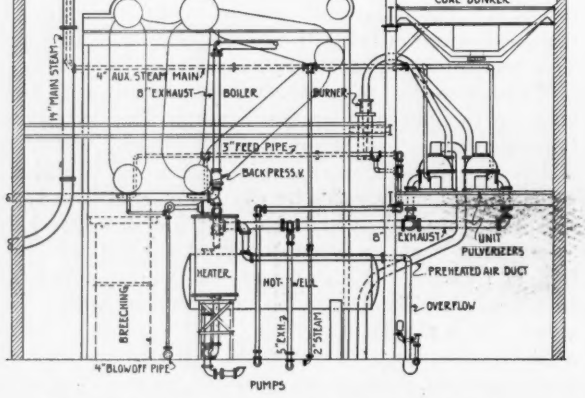


FIG. 1. SECTION THROUGH BOILER HOUSE SHOWING PULVERIZER LOCATION

Steam for these turbo-generator units is supplied by two water tube boilers fired by pulverized coal. This coal is pulverized by turbine driven, unit mills and burned in air-cooled furnaces with water screens. This equipment is installed in a separate boiler house, Fig. 5C, and has given extremely satisfactory results, as shown by the operating data given hereafter. Inasmuch as all exhaust steam from the turbines is used in the processes, while exhaust from turbine-driven boiler auxiliaries heats feed water, the overall performance of the power equipment is economical, a feature of considerable importance in a paper mill where the power cost is a fairly large percentage of the total cost of the product.

TURBINES SUPPLY POWER FOR SECTIONAL DRIVES

For driving the paper machines the sectional drive arrangement of the General Electric Co. is used. In this system the various sections of the paper machines are driven by separate direct current motors so that the speed can be varied at will. Synchronous regulating devices are provided on these driving motors to synchronize the speed of the various parts of the machine. For supplying direct current to these driving motors, each paper machine is equipped with a turbo-generator set installed in the basement underneath the machine, as shown in Figs. 5A and 5B. These machines take steam at 200 lb. gage pressure and 100 deg. superheat at the throttle and exhaust at atmospheric pressure into the drying rolls of the paper machines above. Condensate from these rolls is trapped back to the hotwell

in the boiler house. One of these turbo generators is a 500-kw. unit, the 300-v. generator being driven at 900 r.p.m. through a reduction gear from the turbine running at 3600 r.p.m. On the shaft of this machine is mounted a 35-kw., 125-v. exciter, as shown in Fig. 5B. The other generating unit consists of a turbine operating at 5000 r.p.m. driving a 300-kw., 250-v. generator at 1200 r.p.m. through a reduction gear. This unit also has a direct-connected 30-kw., 125-v. exciter.

These exciters provide power for excitation of the paper machine driving motors and the main generator, since this separate excitation is a part of the control system of the paper machines. Certain parts of the speed regulating devices on the paper machines require alternating-current, which is supplied by a generator driven by a silent chain from the drier section motor. The above exciter also furnishes excitation for this a.c. generator. The exciter on each machine, therefore, has different functions from the usual exciter and the operation of the turbo-generator is really part of the operation of the paper machine. As a matter of fact, the whole drive is supplied as a unit by the manufacturer.

Control boards for the turbo-generator, as well as for all the motors of the paper machine drive, are installed in the basement near the generating units, the entire control in the machine room being by push buttons and controllers on the various sections of the machine. The control boards include voltage regulator and generator panels and a panel for each driving motor carrying thermal relays, contactors for regulator motors, accelerating contactors for motors, control switches and rheostats and an ammeter.

Inasmuch as constant speed alternating-current motors are desirable for driving machinery in the soda mill, this part of the plant is supplied with a turbo-generator set installed as shown in Fig. 4. This unit consists of a steam turbine taking steam at 200 lb. gage and exhausting at about 10 lb. gage to certain of the chemical processes. The turbine runs at 3600 r.p.m. and through a reduction gear drives a 600-kv.a., 600-v., 0.8-p.f., 25-cycle, 3-phase generator at 750 r.p.m. This generator has a direct-connected 12-kw., 125-v., exciter and its own control board.

Since there are several alternating current motors in the machine rooms driving beaters, jordans and

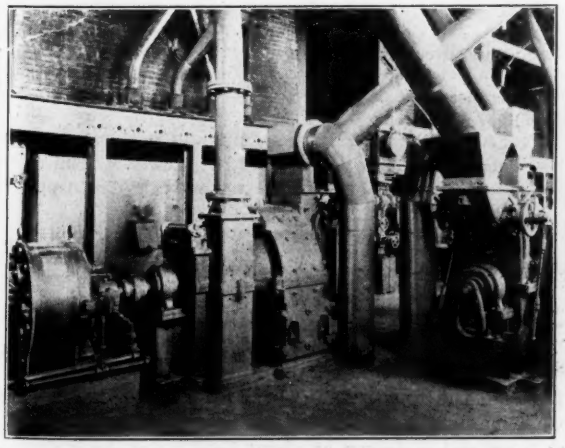


FIG. 2. TURBINES DRIVE PULVERIZING MILLS, WHICH ARE SUPPLIED WITH PREHEATED AIR FROM BOTTOM OF FURNACE

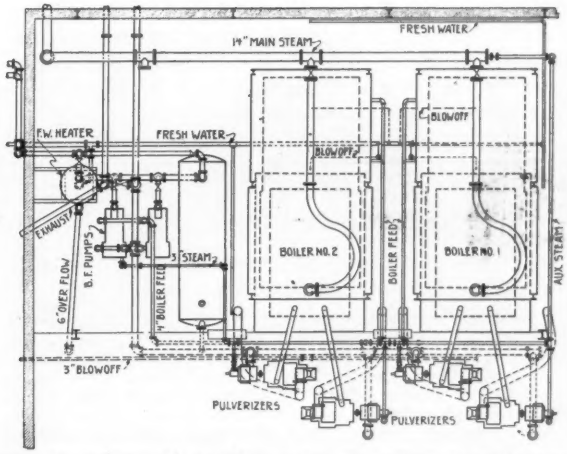


FIG. 3. PLAN OF BOILER HOUSE SHOWING MAIN PIPING, BOILERS AND AUXILIARIES

pumps and since considerable alternating-current is needed for the lighting system, this power is purchased, entering the plant through underground cables and going direct to the outdoor substation, shown in Fig. 5D. This substation, designed and erected by the company's electrical engineer, is of extremely compact and interesting design. It contains two banks of oil-cooled transformers, 400 kv.a. each, stepping power down from 4600 v. to 600 v. for the a.c. motor circuits. For lighting circuits and small motors the power is again stepped down to 220 and 110 v. by a bank of three 37.5 kv.a. transformers. If, for any reason, the outside power should fail, an automatic throw-over device is provided on the control board of the 600-kv.a. a.c. generator in the soda mill; this throw-over device would switch this generator over to the mill lighting circuits so that the paper machines could continue to operate. Since interruptions of outside service are not expected to be frequent or of long duration, this arrangement eliminates costly paper machine shut-downs for short periods.

Boilers, Furnaces and Pulverizing Equipment

Steam for the above turbo-generators is supplied at 200 lb. gage, 100 deg. superheat by two water-tube boilers of the type shown in Fig. 6. These boilers are set high with a standard form of pulverized coal furnace.

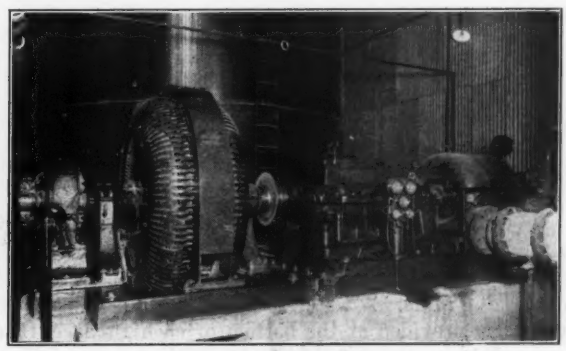


FIG. 4. THIS 600-KV.A. GEARED TURBO-GENERATOR UNIT SERVES SODA MILL AND IN EMERGENCIES IS THROWN ON LIGHTING SYSTEM

Furnaces each have a volume of 3100 cu. ft. and are of the air-cooled hollow wall construction, as shown in the sectional view. Each furnace has a false bottom giving an air space through which air is drawn to be preheated and then passes up through the ducts to the pulverizing mills. A water screen of 178 sq. ft. heating surface is provided at the bottom of each furnace, this screen being connected, as shown, with the circulating system of the boiler. Burners enter the furnace through a flat suspended arch at the top. At a later date, it is planned to replace the present air-cooled walls with fin-tube water walls.

Coal burned by the Tonawanda Paper Co. is mostly mine run coal from Pennsylvania and West Virginia. This is pulverized in unit mills set, as shown in Figs. 1 and 2, on the operating floor about 5 ft. below the burner level. Two mills are installed for each boiler, although under most conditions three mills will carry the load, the fourth being held as a spare. Each mill has a maximum capacity of between two and three tons an hour and is driven at about 1800 r.p.m. by a direct-connected steam turbine. Figures 2 and 5A show this arrangement. There are four burners in each furnace and each mill supplies two burners, the coal discharge

Principal Power Plant Equipment of Tonawanda Paper Co.

Turbo-Generators, Accessories and Electrical Equipment

2 General Electric Co. geared turbo-generator sets: No. 1 unit, turbine, 3600 r.p.m. drives 500-kw., 300-v., d.c. generator at 900 r.p.m.; separate direct-connected 35-kw., 125-v., exciter. No. 2 unit, turbine 5000 r.p.m. drives 300-kw., 250-v., d.c. generator at 1200 r.p.m. through reduction gear; separate 30-kw., 125-v. direct-connected exciter. For both units throttle pressure 200 lb. gage, 100 deg. superheat, exhaust at atmospheric pressure to paper machine driers.

1 Elliott Co. Kerr turbine at 3500 r.p.m. driving 600-kv.a., 600-v., 0.8-p.f., 25-cycle, 3-phase General Electric Co. generator at 750 r.p.m. through Kerr reduction gear. Throttle pressure 200 lb., 100 deg. superheat, back pressure 10 lb. gage. Direct-connected 12-kw., 125-v. G.E. exciter.

James G. Biddle vibrating reed tachometers on each machine.

3 General Electric Co. control boards; 1 for each turbine with meters, breakers, contactors and relays for sectional paper machine control; 1 for soda mill.

6 General Electric Co. oil-cooled transformers, 400 kv-a. each, 4600/600-v., in outdoor substation (2 banks).

Outdoor substation switching and protective equipment.....Delta Star Electric Co.

3 Packard Electric Co. transformers, each 37.5 kv-a., 550/220/110-v. for 3-wire lighting circuits.

Boilers, Furnaces and Pulverizers

2 Badenhausen Corp. preheater type water tube boilers, 10,200 sq. ft. heating surface each with superheaters to give 100 deg. of superheat. Operating pressure 200 lb. gage.

2 Combustion Engineering Co. Lopulco water screens (1 per boiler) 178 sq. ft. heating surface each.

2 furnaces, Lopulco air-cooled, hollow wall type with hollow bottom. Celite Products Co. Sil-O-Cel insulating brick and standard firebrick construction. Bigelow Arch Co. suspended arches at burners.

4 Raymond Bros. No. 50 Imp Pulverizing Mills, 2 per boiler, furnished by Combustion Engineering Corp., each direct driven by a 60-hp., 1800-r.p.m. Kerr turbine.

8 Combustion Engineering Corp. Lopulco pulverized coal burners, 4 per boiler.

Soot Blowers.....Diamond Power Specialty Co.

S-C Feed water regulators.....The Swartwout Co.

Blowoff valves .....Yarnall-Waring Co., Everlasting Valve Co.

Gage columns with high and low water alarm.....Reliance Gauge Column Co.

Feed Water Pumps and Heaters

2 Alberger (Wheeler Condenser & Engineering Co.) 3-stage centrifugal boiler feed pumps, type H, each 350 g.p.m. against 550-ft. head driven at 2560 r.p.m. by Alberger-Curtis steam turbines.

1 Cochrane Corp. deaerating feed water heater, capacity 125,000 lb. an hr.

1 The Permutit Co. zeolite water softener, capacity 180,000 gal. per 24 hr.

1 Norwood Engineering Co. sand filter.

2 Sherwood Mfg. Co. Buffalo injectors, 1 per boiler, for emergency boiler feeding.

Coal Handling Equipment

Coal handling equipment furnished by Root, Neal & Co.

1 Brownhoist locomotive crane.....Brown Hoisting Machinery Co.

1 Farnham Mfg. Co. 4-roll crusher, 50 t. an hr.

1 Magnetic Pulley Co. magnetic pulley.

Farnham Mfg. Co. hopper, conveyor feeder, bucket elevator and belt conveyor over bunkers.

1 Reinforced concrete coal bunker made by Tonawanda Paper Co.

Draft Equipment

2 B. F. Sturtevant Co. induced draft fans, each rated at 68,000 c.f.m., 2 in. static pressure, 300 deg. F., driven by Sturtevant vertical steam engines controlled by Mason fan regulators.

1 Boiler breeching 5 ft. by 16 ft. fabricated by Lackawanna Steel Co., erected by Tonawanda Paper Co.

1 M. W. Kellogg Co. radial brick chimney, 125 ft. high, 10 ft. average inside diameter.

Miscellaneous Equipment

Piping from Farnham Mfg. Co., furnished by Root, Neal & Co., installed by Tonawanda Paper Co.

High pressure steam pipe.....Jones & Laughlin Extra heavy with Lovekin joints.

Stop and check valves and high pressure steam valves .....The Wm. Powell Co. Extra heavy gates and globes, monel fitted.

Reducing valves.....Mason Regulator Co.

Pipe covering.....Johns-Manville, Inc.

Gratings and stairs.....Irving Iron Works

Hoists for handling pulverizer parts.....Yale & Towne Mfg. Co.

Indicating and recording flow meters.....General Electric Co.

Steam pressure recorder.....American Schaeffer & Budenberg Corp.

CO_2 recorders.....Uehling Instrument Co.

Miscellaneous gages .....Ashcroft (Manning, Maxwell & Moore, Inc.)

Draft gages.....Lewis M. Ellison

Condensate handled by Stickle system with Armstrong steam traps.

1 W. N. Best Corp. swivel burner for fuel oil with Morris and Dean Bros. oil pumps for emergencies, Sunday work and starting up.

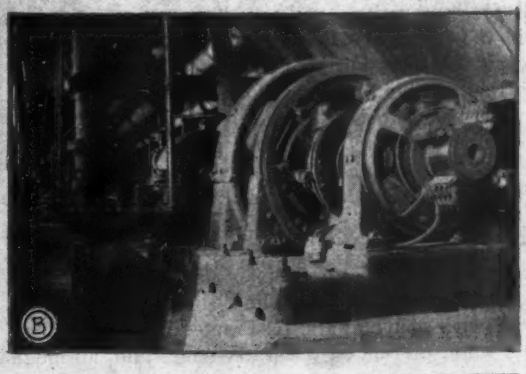
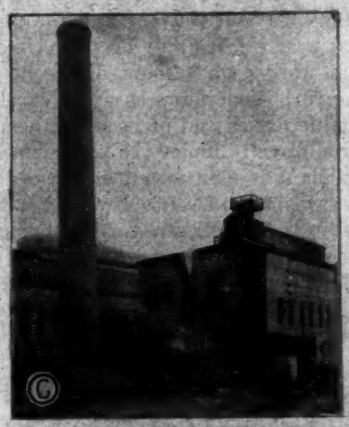
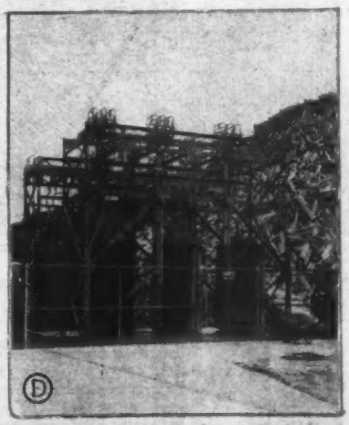
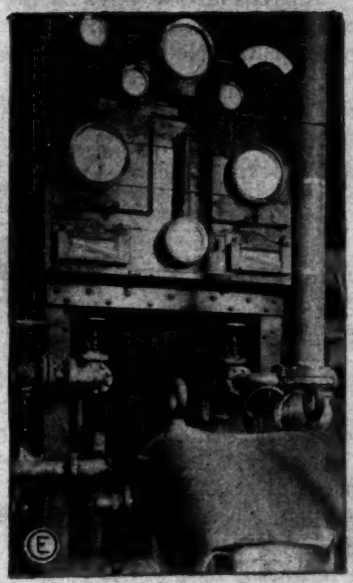


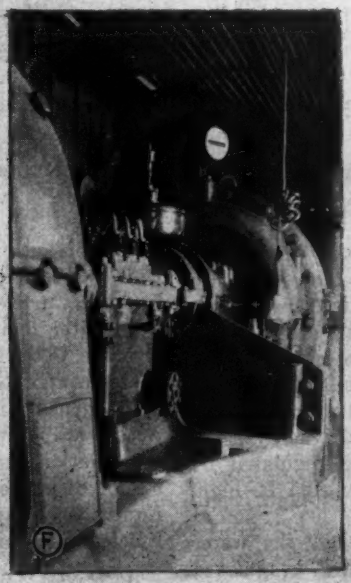
Fig. 5. Power Plant Equipment at Tonawanda Paper Co.



A—View of operating floor showing pulverizing mills. B—Below each paper machine, supplying power to the sectional motor drive, is a turbo-generator. C—Exterior view of boiler house, showing chimney and bucket elevator. D—Purchased power is brought into plant through this substation. E—A convenient gage board is located between the boilers just above the operating floor. F—Turbine end of one of the turbo-generators. G—Rear of boilers showing water screen headers.







pipe branching to alternate burners, as shown in Fig. 2, to give better flame distribution when one mill is operating alone. Burners are of the standard fan tail type, the long axis of the burner being cross-wise of the furnace. Oil burners are installed for emergency operation or for starting up after a shut-down.

Under ordinary conditions, boilers are operated at about 200 per cent of rating. Total moisture in the coal will average about 12 per cent and no trouble has been encountered from this source. Preheated air, drawn from the space under the furnace floor is led up to the pulverizers, as shown in Figs. 1, 2 and 6, and

aids in drying the coal during pulverization. Secondary air for combustion is admitted through the control ports in the furnace walls, although a small amount is also admitted at the burner air intake. Coal is pulverized so that 85 per cent goes through 200 mesh screen.

Between the two boilers and just above the operating floor is a completely equipped gage board, Fig. 5E. This carries indicating flow meters, pressure recorders and gages, CO_2 recorder, and draft gages so that the condition of the boilers can be determined from the readings of these gages. Other meters of both indicating and recording types give steam flow to turbines and other equipment, water flow and so on. Boilers are equipped with soot blowers, feed water regulators, high and low water alarms on the water gages and, although

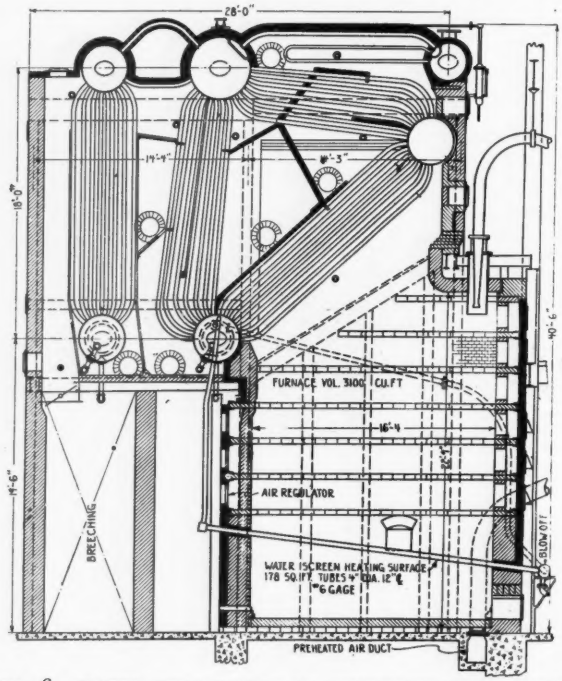


FIG. 6. WATER TUBE BOILER OF PREHEATER TYPE WITH SUPERHEATER IS SET WITH AIR-COOLED FURNACE

the boiler room is not complicated, every facility is provided for securing best results from the equipment. Draft for the boilers is provided by induced draft fans, each rated at 68,000 c.f.m. at 2 in. pressure and 300 deg. Flue gas passes down after leaving the last pass into the breeching shown in Fig. 6, which leads straight out to the fan room, which is just outside the boiler room, between it and the chimney. Fans are driven by small vertical steam engines, the speed being regulated by fan regulators. A radial brick chimney, 125 ft. high, discharges the flue gas.

Ash from the furnaces drops through the water screen into the space below, from which it is removed by hand into wheelbarrows and taken out of the boiler house. Coal can be unloaded into a storage pile from the cars by means of a locomotive crane or the cars can be run up on the trestle shown in Fig. 5C and dumped into a hopper. The crane can also reclaim coal from the pile to load into this hopper. From here a belt conveyor takes it to a crusher, which discharges to a bucket elevator running up the outside of the building and discharging over a magnetic pulley to another belt conveyor running across the coal bunker.

All condensation from the paper machines, heating system, and so on is brought back to a large steel hotwell tank in the boiler house, as shown in Figs. 1 and 3. Feed water is heated to about 212 deg. by an open type deaerating feed water heater with a capacity of about 125,000 lb. an hour, steam for heating the feed water being supplied by the exhaust from pulverizer turbines, boiler feed pump turbines and fan engines. Makeup water, previously treated by a zeolite water softening system, is introduced here and the feed water is sent to the boilers by two 350-g.p.m., 3-stage centrifugal boiler feed pumps which are driven at 2560 r.p.m. by steam turbines. Each boiler is also equipped with an injector for feeding in an emergency. All water entering the plant for process work and boiler feed is first passed through a sand filter.

Operation of the power plant equipment described above has been extremely satisfactory and the plant is typical of the best practice in applying pulverized coal to industrial plant work. On account of the necessity of considering the turbo-generators as an integral part of the paper machine drives and of locating them with their control boards directly under the paper machines, the layout of the plant is a little out of the ordinary. The arrangement saves much electrical wiring, however, the high-pressure steam line losses are small and this arrangement possesses many advantages.

As an example of what has been done in operating this plant, the attached report of a test conducted on No. 2 boiler shows an overall boiler room efficiency of 86 per cent.

EVAPORATION TEST ON NO. 2 1020-HP. BOILER

Analysis of Coal

Moisture—		Moisture	1 per cent
Fixed	1 per cent	Volatile matter	29 " "
Surface	4 " "	Fixed carbon..	58 " "
Total	5 " "	Ash	12 " "
			100

Heat value of coal by proximate analyses	13,419 B.t.u.
Horsepower developed	1253
Rating	125 per cent
Boiler pressure	205 lb. gage
Flue gas temperature	292 deg. F.
Draft in furnace	0.03 in.
Feed-water temperature	163 deg. F.
Average CO_2	12 per cent
Water evaporated per hr	39,476 lb.
Coal burned per hr	3683 lb.
Actual evaporation per lb. coal	10.69 lb.
Evaporation per lb. of dry coal	11.25 lb.
Factor of evaporation	1.095
Equivalent evaporation	12.31 lb.

Efficiency of boiler and furnace

$$(970.4 \times 12.31) \div 13{,}419 = 89 \text{ per cent.}$$

3 per cent of total used for pulverizer, draft fan and feed pump, leaving 86 per cent combined efficiency.

Warren Curtis is president and general manager of the Tonawanda Paper Co., M. Derrico is superintendent, G. H. Jaeger is draftsman and F. S. Janes is purchasing agent. The power plant design and construction was carried out under the direction of these men, whom we wish to thank for data and illustrations.

Decayed Piling Replaced with Concrete

Old Piles Cut Off Below Water Level and Concrete Retaining Wall With Two Rows of Anchor Piles Built at Total Cost of $160 Per Lineal Foot. By S. S. Dougherty*

CIRCULATING WATER for the Acme Plant of the Toledo Edison Co. is taken from the Maumee River about 4 mi. above where it flows into Lake Erie. Except in time of flood, the river level is approximately the same as the lake and, as shown on Fig. 1, remains practically constant throughout the year.

From the end of the intake tunnels at the screen house, a canal about 300 ft. long, 60 ft. wide and 22 ft. deep is provided to within 10 ft. of the harbor line. The banks of the canal were maintained by sheet piling reinforced by round piles driven on 2-ft. centers, as indicated on Fig. 2. This piling also served to divide the intake and discharge canal, as shown in 3-A. The derrick scow is moored in the intake canal.

This piling was driven in 1917 and Fig. 3-E, a photograph taken in 1924, shows that 7 yr. is about the life of mixed oak piles exposed to the weather. Oak piles last indefinitely below the water line but the anchorage of this retaining wall was attached to the wall and to anchor piles well above the water line as indicated in

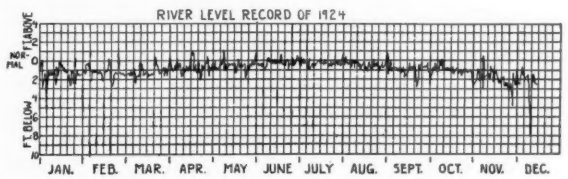


FIG. 1. WATER LEVEL SHOWS SMALL VARIATION THROUGHOUT THE YEAR

Fig. 2A. It was feared that as the wood rotted the anchorage would lose its value and some of the wall might cave in.

After a thorough consideration it was decided that the timber work along the intake canal and 50 ft. on either side should be cut off below the water line and a concrete retaining wall set on it. The remaining portion was not altered because the harbor is not dredged and the piling used only as a deflector to prevent recirculation of the water is not depended on as a retaining wall.

Daily river levels were plotted over a period of 4 yr., Fig. 1, for 1924 only, being representative as all years had the same general trend; Figure 2C shows the principal features of the final design as submitted by the engineering offices of H. L. Doherty & Co.

Old Piles Cut Off 1.5 Ft. Below Normal Water Level

It was decided that the periods of time during which the water level dropped to below 1.5 ft. below normal were of such short duration that little decay could take place. The cutoff was, therefore, made at 1.5 ft. below normal water line and the waling strips set flush with the top of the piling.

The height of the wall was made the same as the old one so that it would match in height that part which was not renewed, while 1½-in. pipe sleeves were set in the top step of the wall so that if in the future a waling piece should be needed to protect the wall against the chafing of moored vessels it could easily be attached.

To support the toe or inside edge of the concrete retaining wall, a line of new pile, as in Fig. 2B, was driven on 6-ft. centers, fastened to the old work by 1-in. tie bolts and 1½-in. pipe spacers. In the direction

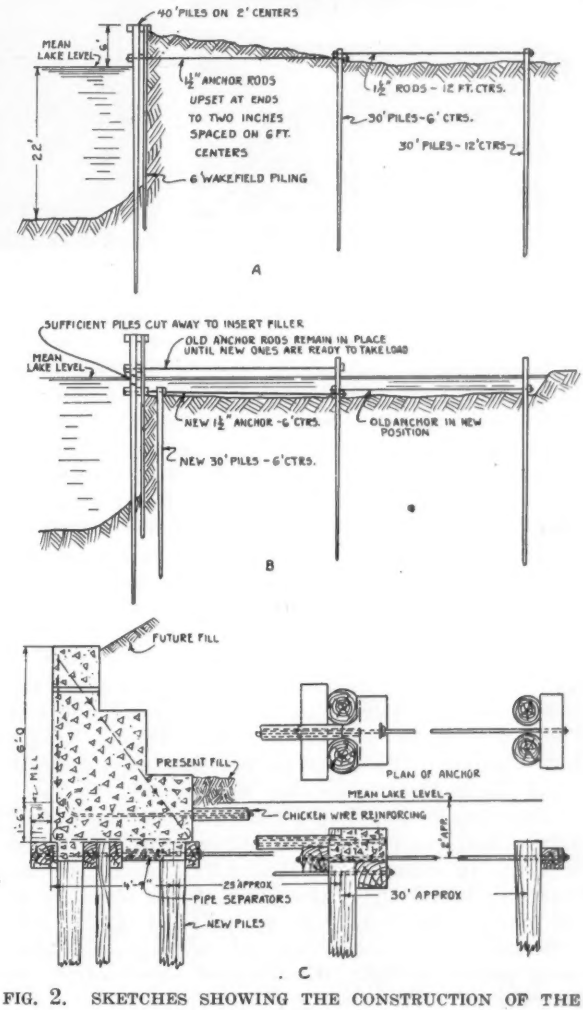

40' PILES ON 2' CENTERS
MEAN LAKE LEVEL
1½" ANCHOR RODS UPSET AT ENDS TO TWO INCHES SPACED ON 6 FT. CENTERS
1½" RODS - 12 FT. CTRS.
30' PILES - 6' CTRS.
30' PILES - 12' CTRS.
6' WAKEFIELD PILING
A
SUFFICIENT PILES CUT AWAY TO INSERT FILLER
OLD ANCHOR RODS REMAIN IN PLACE UNTIL NEW ONES ARE READY TO TAKE LOAD
MEAN LAKE LEVEL
NEW 1½" ANCHOR - 6' CTRS.
OLD ANCHOR IN NEW POSITION
NEW 30' PILES - 6' CTRS.
B
FUTURE FILL
PRESENT FILL
PLAN OF ANCHOR
MEAN LAKE LEVEL
CHICKEN WIRE REINFORCING
2'APPR.
2' APPROX
PIPE SEPARATORS
30' APPROX
NEW PILES
C

FIG. 2. SKETCHES SHOWING THE CONSTRUCTION OF THE OLD AND NEW WALLS

parallel to the wall these new piles are held in place by a new 6 by 12-in. waling strip.

Two Rows of Anchor Piles Used

Old anchor rods were hooked on one end, set in the wall and incased in concrete throughout their entire length. Secondary anchor rods running from the first to the second line of anchor piles were lowered to about 2 ft. below mean lake level so that, should the piles rot off to the water level, the rods would still hold.

Expansion joints were provided about every 50 ft. and a 1-2-4 mixture of concrete specified with enough

*Acme Plant, Toledo Edison Co.

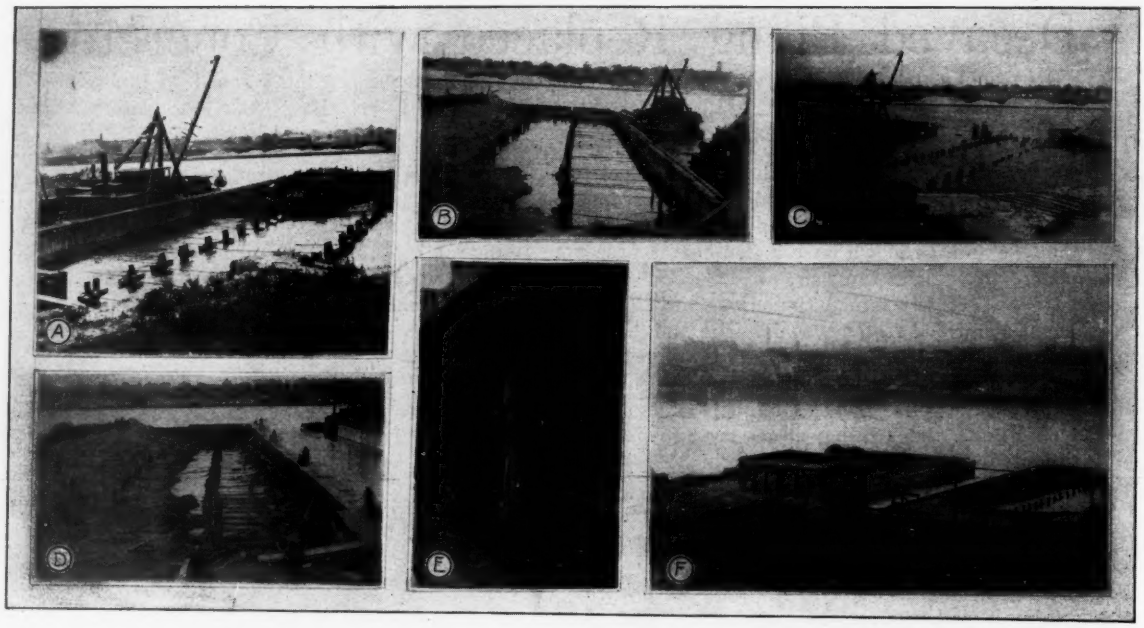


FIG. 3. PHOTOGRAPHS OF THE WORK AS IT PROGRESSED AND OF THE COMPLETED CONCRETE WALL

reinforcing steel used to take care of all reasonable stresses from temperature, earth load and ice pressures.

About 50 ft. of the wall next to the mouth of the discharge had relatively deep water on both sides. It was felt that without the earth load to keep the anchor rods tight and the wall in place, the piling standing unsupported in the water was hardly stable enough to set the concrete wall on. To strengthen this section an additional line of sheet piling was driven and the space between the two lines of sheet piling was filled with gravel.

Considerable excavation was necessary in order to get the anchor rods in position. Figure 3-A shows the excavation being started on the downstream side and Fig. 3-B shows the excavation almost complete on the upstream side. This latter picture also shows the new round pile in place before they were cut off.

After excavating deep enough to place the anchor rods in their new position, the waling strips were bolted in place. In order to place these 6 by 12-in. timbers between the round and sheet piling, it was necessary to cut some of the round pile, as indicated in Fig. 2-B. New anchor rods were then put in place and, after being pulled up tight, the old work was ready to be cut off.

Much of the cutting work fell below the mean water level. As the curve shows, the water is low a good portion of the time in the late summer and advantage was taken of this; however, quite a bit of work was actually done in the water. A great many days the younger men worked naked and did not seem to mind it, but frost had come before the job was finished and with water too cold for comfort, the men wore wading suits. The piles were cut off flush with the waling by means of crosscut saws and axes. Figure 3-C shows part of the wall cut down.

The face of the concrete was kept on a line, determined after the cutoff was finished, and this made the dimension designated as "X," Fig. 2C, vary. Actually it varied from a positive 12 in. to about a negative 15 in. At points where X became negative and the face of the wall projected over beyond the timber work, it was found advisable to increase the thickness of the concrete retaining wall at the bottom.

Space between the sheet piling and the new round piles was back-filled to make the bottom of the form for the concrete wall. Spaces between the old round piling, however, had to be provided with a bottom form. Rather tedious work, as the forms were made fairly tight and the remaining cracks filled with wedges and stiff clay.

Forms Were Covered to Form Walkway for Wheeling Concrete

By laying panels across the top of the forms a gangway was made for wheeling the concrete. Figure 3-D shows the forms in place. This photograph also shows forms being placed for giving the anchor rods their concrete protection. The work complete with the backfill is shown in Fig. 3-F, the total cost of the work amounting to slightly less than $160 per lineal foot.

To help resist ice pressure the downstream side (right hand) and the corner were back-filled to the top of the wall, but the remainder was back-filled only to the top of the first step of the retaining wall. This back-filling was done to give the anchor rods and piles mechanical protection as well as prevent the depositing of cinders around them. Most filling about a power plant is done with cinders but, if used for filling around the anchor rods, acid from the cinders would soon eat them away.

Whatever it is that puts a damper on the individual initiative of a man and cools the fires of ambition and personal effort to excel, that thing will prove costly to him and the world in general. In such a state there can be no progress and time will prove this by showing stagnation and decay.

Factors Affecting Economy of Turbine Operation

AIR PREHEATING AND FEED WATER HEATING ARE OF INCREASED VALUE AS PRESSURES INCREASE. RESUPERHEATING HAS CHIEF VALUE IN ELIMINATING WETNESS AT EXHAUST. BY H. L. GUY*

DURING the last 10 yr. thermal efficiency of the best power stations has been improved some 50 per cent. Of the changes, that in steam pressure is perhaps the most striking, the maximum steam temperature remaining about stationary and vacuum, with given water temperatures, seeming to fall slightly. Regenerative feed heating by steam extraction from the turbine at various stages and resuperheating have changed the steam cycle, the advantage of these operations depending upon the initial steam pressure used. In his paper Mr. Guy has considered from the theoretical standpoint how these factors affect the efficiency of operation and what steam pressure may be appropriate for any given set of conditions.

In Fig. 1 is shown diagrammatically the type of installation considered, consisting of steam turbine with resuperheating provision, stages of regenerative feed heating and boiler equipment of economizers and air preheaters. Study is primarily devoted to the influence of steam pressure on station economy, but the effect of other factors varies with the steam pressure so that they must be considered.

CONDITIONS TAKEN AS STANDARD

As a standard for comparison, a plant is taken with pressure of 200 lb., superheat to give total temperature of 700 deg. F. at the stop valve and a vacuum of 29 in. referred to a 30-in. barometer reading. Individual stage efficiency of 80 per cent was assumed for dry steam and the variations in heat available, thermal efficiency, turbine efficiency and other factors were computed for such a plant under varying steam pressure, the results being as shown on the curves in Fig. 2.

In curve A is shown the increase of total heat per lb. of steam compared to that at 200 lb. and 700 deg. F. with the pressure increasing, temperature at the stop valve remaining constant at 700 deg. Curve B shows the available heat for various pressures with steam expanding adiabatically to 29 in. vacuum in all cases. Curve C shows the ratio of B to A which would give an approximate indication of the thermal efficiency. Curve D shows the correction to be applied to C because of reheat and curve E the loss in efficiency due to condensation during expansion, taken at 1 per cent loss for each 1 per cent mean wetness in the stage considered.

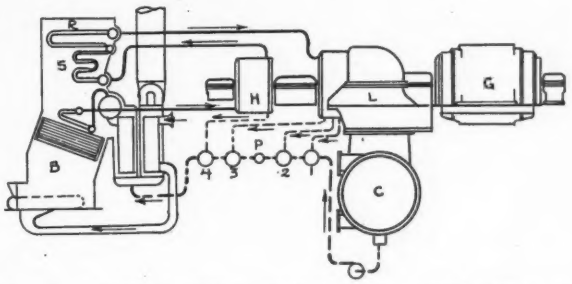


FIG. 1. MODERN STEAM PLANT WITH AUXILIARIES, B, BOILER; C, CONDENSER; G, GENERATOR; H, HIGH-PRESSURE TURBINE; L, LOW-PRESSURE TURBINE; P, FEED PUMP; R, RESUPERHEATER; S, SUPERHEATER; 1, LOW-PRESSURE FEED HEATER; 2, INTERMEDIATE HEATER; 3, FIRST HIGH-PRESSURE HEATER; 4, SECOND HIGH-PRESSURE HEATER

Correcting curve C for the factors D and E gives curve F.

Mean corrections for turbine losses affected by pressure, at the rate of 1 per cent increased loss each time the pressure is doubled, gives curve G, the final turbine thermal efficiency. The relatively small loss as between F and G can be obtained with plants of reasonable size for the speed at which they operate, such as 40,000 kw. at 1500 r.p.m., 20,000 kw. at 3000 r.p.m. or 10,000 kw. at 6000 r.p.m. as maximum continuous ratings. Possibly to get this condition it may be expedient to gear drive the high-pressure end of a compound turbine, which would introduce additional loss of 1¼ to 2 per cent and also slightly reduce the combined efficiency of

*From a paper before Northwestern Branch, Institution of Mechanical Engineers. Acknowledgments to Engineering of London, England.

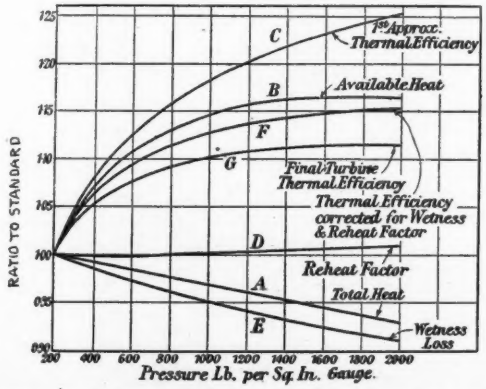


FIG. 2. HEAT SUPPLIED AND EFFICIENCIES VARY WITH PRESSURE AS SHOWN FROM A TURBINE USING 200 LB. GAGE, 700 DEG. F. AND 29 IN. VACUUM TAKEN AS A STANDARD OF COMPARISON

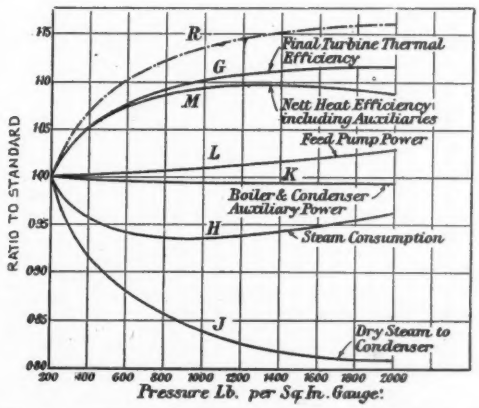


FIG. 3. POWER FOR AUXILIARIES AFFECTS NET PLANT EFFICIENCY

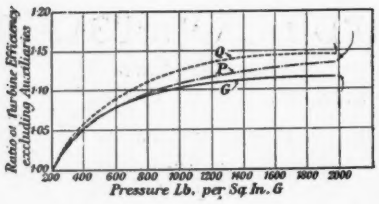


FIG. 4. INCREASING SUPERHEAT AND DECREASING VACUUM ADD TO TURBINE EFFICIENCY. CURVE G, 700 DEG., 29 IN. VACUUM; CURVE P, 900 DEG., 29 IN.; CURVE Q, 700 DEG., 28 IN.

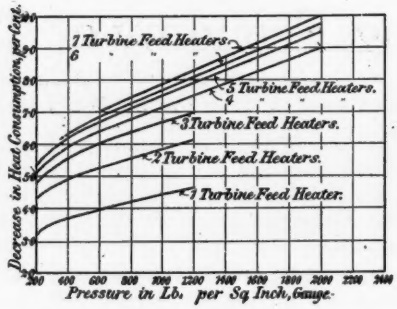


FIG. 5. REGENERATIVE FEED HEATING REDUCES HEAT CONSUMPTION. ECONOMIZER USED BUT NO AIR PREHEATER

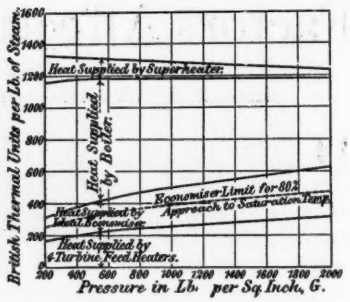

British Thermal Units per Lb. of Steam
Heat Supplied by Superheater.
Heat Supplied by Boiler.
Economiser Limit for 80% Approach to Saturation Temp.
Heat Supplied by Ideal Economizer.
Heat Supplied by 4 Turbine Feed Heaters.
Pressure in Lb. per Sq Inch, G.

FIG. 6. HEAT PER POUND OF STEAM IS SUPPLIED AS SHOWN. NO AIR PREHEATER

the unit by perhaps ¾ per cent of the total output at maximum rating.

Effect of Auxiliaries

Increase of steam pressure also affects the power absorbed by condenser and boiler auxiliaries, therefore the heat consumption and the economic output of the plant. Variation of steam consumption per kilowatt generated varies as shown in Fig. 3, curve H. Change in power for the feed pump is shown by curve L, expressed in terms of power of the main set and assuming electrically driven feed pumps with normal output corresponding to maximum continuous rating. Pump discharge pressure was taken at 50 lb. greater than steam pressure at the turbine stop valve and pump efficiency as varying from 75 per cent at 250 lb. gage to 65 per cent at 2050 lb. gage. Motor efficiency was taken at 90 per cent. J shows the decrease in the amount of dry steam to be condensed as pressure increases and power taken by condenser auxiliaries will vary directly with this. Boiler stokers and fans will take power decreasing with the amount of coal burned, hence varying inversely as curve G, which is the same as G on Fig. 2.

Combining the power used by auxiliaries for condensers, stokers and fans, this decreases with increase of pressure as shown by the curve K, and correcting curve G for this variation in power of the auxiliaries results in curve M, the net plant gain in heat efficiency with increasing steam pressure. It is interesting to note that while the final turbine thermal efficiency shows a continual rise, this is quite slow after the pressure reaches 1000 lb., and, when the effect of auxiliaries is included, a maximum heat efficiency is reached at about 1300 lb., beyond which point this net heat efficiency decreases.

Effect of Superheat and Vacuum on Thermal Gain

Results charted in Fig. 4 show the effect as compared to curve G of Figs. 2 and 3 of a change in the amount of superheat and also of a change in the vacuum. Curve P represents conditions when 900 deg. F. is used at the turbine stop valve and curve Q the effect when vacuum is reduced to 28 in. Over the range up to 1200 lb., the increase in initial temperature of the superheated steam has comparatively little effect but the use of 28 in. vacuum indicates a considerable gain at the highest pressures, amounting to 2.35 per cent at 2000 lb. This would be reduced to a gain of 2.05 per cent, if regenerative feed heating were used in both cases and the effect of auxiliary power taken into account.

Variations in the total heat of steam and the heat drop available during adiabatic expansion will affect the conclusions in the curve to a certain extent and the author discusses the variations in these values of the properties of steam as shown by the work of various authorities. He points out that research is now being carried on to ascertain accurately the properties of steam right up to the critical pressure and that in all probability modification in estimates, which may be necessary when this experimental work has been completed, will be of such nature as to reduce slightly the gains to be expected from increased steam pressure.

To determine the effect of regenerative feed heating on thermal efficiency, estimates were made for various

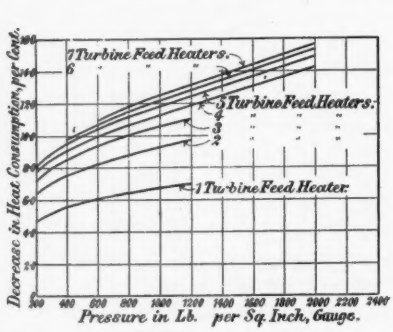


FIG. 7. AIR PREHEATING DECREASES HEAT CONSUMPTION. ECONOMIZER AND AIR PREHEATER USED

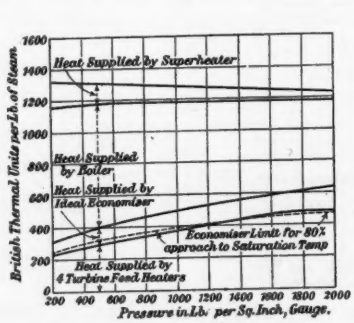

British Thermal Units per Lb. of Steam
Heat Supplied by Superheater
Heat Supplied by Boiler
Heat Supplied by Ideal Economizer
Economiser Limit for 80% approach to Saturation Temp
Heat Supplied by 4 Turbine Feed Heaters
Pressure in Lb. per Sq. Inch, Gauge.

FIG. 8. USE OF AIR PREHEATER LESSENS NEED FOR ECONOMIZER

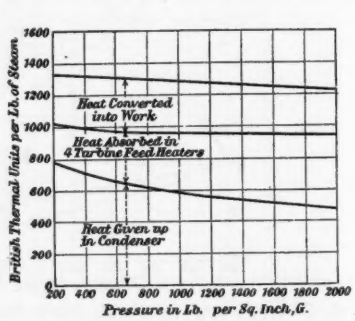

British Thermal Units per Lb. of Steam
Heat Converted into Work
Heat Absorbed in 4 Turbine Feed Heaters
Heat Given up In Condenser
Pressure in Lb. per Sq. Inch, G.

FIG. 9. A POUND OF STEAM GIVES UP ITS HEAT AS HERE INDICATED. ECONOMIZER AND AIR PREHEATER USED

combinations of turbine feed heaters and at various pressures, the results being shown in Fig. 5. Decrease in heat consumption due to stage heating is continuous with rise in pressure and is almost twice as great at 2000 lb. as at 200 lb. On the other hand, use of turbine feed heaters beyond three in number would seem of doubtful economic value because of the slight gain as compared with increased investment. Considering, however, usual practice as well as possibilities, four feed heaters have been taken as the number to be used in making further comparison.

Working on this assumption, the heat supplied per lb. of steam for each main source is shown in Fig. 6, and it is interesting to note the change in the proportion of the heat supplied by heaters and economizer as the pressure increases. The full line for economizer heat is on the assumption of raising the feed water temperature to that of saturated steam corresponding to boiler pressure. If, instead of the ideal economizer, heating by that apparatus is limited to 80 per cent of saturated steam temperature in order to avoid boiling of water in the economizer, the heat supplied by the economizer will be shown between the lowest full line and the dotted line.

Effect of Air Preheating

Equipping boilers with both economizers and air preheaters results in the condition shown in Figs. 7 and 8. Addition of the air heater has increased the improvement in heat consumption by approximately 50 per cent but, if limitation of maximum temperature of water to 80 per cent of boiler temperature is imposed, the heat supplied by the economizer practically disappears as shown by the dotted line in Fig. 8. If water can be heated up to full boiler temperature, the economizer still has a share of usefulness, as otherwise the heat absorbed in the air heater may give too high air temperature for comfortable working. Such use of the economizer will involve development of apparatus which will permit of boiling in the economizer itself.

Where the Heat Goes

Heat supplied per lb. of steam is used as shown in Fig. 9 for a plant having four-stage feed water heaters, economizers and air preheaters. Increasing importance of the feed heaters with increase of pressure is apparent, also the reduced amount of heat carried to the condenser. It should be remembered that the figures here shown are for 1 lb. of steam, and not per kilowatt generated, so that the lessened amount of heat converted into work does not indicate decreasing efficiency, because steam per kilowatt is decreasing with increase of pressure as shown in Fig. 3, curve H.

Resuperheating of Doubtful Value

Considering the influence of resuperheating on thermal efficiency, a change was made to 750 deg. temperature at the stop valve in order to give resuperheating the most advantageous conditions. This would involve designing the plant for maximum temperature of 800 deg. which is as high as anyone would consider going under present knowledge of the action of materials at high temperatures. With the use of the resuperheater, a pressure loss of 5 per cent is allowed but no loss for radiation in passing through the resuperheater.

Gain from resuperheating depends upon the point in the expansion at which the steam is resuperheated, hence the effect on thermal efficiency was examined for different pressures. The proportion of complete expansion which should precede admission to the resuperheater, to give the greatest advantage, will vary with the pressure as shown in Fig. 10. The lower curves show the variation of thermal efficiency ratio as compared with conditions at 200 lb. pressure and indicate that, with no wetness correction, the value of resuperheating would decrease rapidly with increase in pressure, while with wetness correction the value of resuperheating is continuously greater as pressure increases.

Many tests show that the usual method of correction for wetness gives results agreeing with experience for normal high-pressure condensing turbines but such tests as have been made on resuperheating installations indicate that results are not agreeing with the predictions based on the wetness correction. Judged by results now

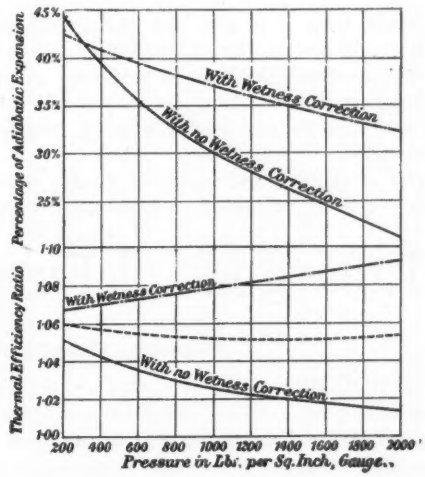


FIG. 10. THE BEST POINT FOR RESUPERHEATING VARIES WITH PRESSURE. TEMPERATURES AT STOP VALVE AND AFTER RESUPERHEAT, 750 DEG.; 29 IN. VACUUM. LOWER CURVES GAIN FROM ONE RESUPERHEATING

available, the gain due to resuperheating would appear not to exceed the mean estimated as between no wetness correction and wetness correction, or that shown by the dotted line in the lower part of Fig. 10. In any case, even if we could take full advantage of the gain as shown by the wetness correction curve, it would still be small, only about ⅛ of 1 per cent for each 100-lb. increase in pressure, and for this reason the effect of resuperheating was omitted in making the final conclusions as to desirable pressures to be used.

It is possible that, if higher pressures are adopted, resuperheating may be imperative, unless higher initial temperature can also be used. With conditions assumed and without resuperheating, water present in the steam at the lower pressure stages increases rapidly. At 200 lb. initial pressure, wetness in the steam at exhaust is 9.5 per cent; with 600 lb. pressure is 15¼ per cent; with 1200 lb. pressure, 20.3 per cent. This would mean that, for a 40,000-kw. turbine at 1200 lb. initial pressure, over 33 tons of water per hour would be passed through the last row of blades, or a stream of 125 gal. of water a minute would be hurled into the exhaust. Whether this will produce corrosion in the blades to

TABLE I. INCREASE OF COST PER KILOWATT CAPACITY WITH INCREASED PRESSURE

Gage Press. lb. sq. in.	200	300	400	500	600	700	800	900	1000
Incr. Cost per hp. $	0.00	0.76	1.74	2.91	4.29	5.87	7.65	9.21	11.85

TABLE II. PRESSURES FOR GREATEST GAIN WITH DIFFERENT LOAD FACTORS

Condition	Capital Charges %	Load Factor Per Cent 100	60	50	30
		Pressure Lb. per Sq. In. Gage			
Air Heater	12	606	495	459	367
No Air Heater	12	575	466	433	350
Air Heater	18	516	417	385	306
No Air Heater	18	477	396	366	293

shorten their lives over that for more moderate conditions is as yet undetermined but, if such should be the case, resuperheating might prove necessary and it is believed that this consideration has played a considerable part in deciding to use resuperheating, where it has been adopted.

Making a careful and detailed study, considering both thermal and financial advantages, conclusions

TABLE III. BEST PRESSURES FOR ½ PER CENT LESS THAN MAXIMUM GAIN

Condition	Capital Charges %	Load Factor Per Cent 100	60	50	30
		Pressure Lb. Sq. In. Gage			
Air Heater	12	460	379	355	285
No Air Heater	12	439	363	345	275
Air Heater	18	394	325	300	238
No Air Heater	18	378	312	289	227

shown in Table I are reached. Capital cost will be increased as pressure is increased, the cost above 800 lb. having been obtained by extrapolation. Operating costs will depend on the load factor and, of course, the most economical conditions considered financially will depend on the overhead charges which are adopted for interest, taxes and depreciation. Results of the study of operating costs are as follows: considering maximum gain, Table II, and also considering that the designer stops at ½ per cent short of the maximum gain, Table III.

In future increased cost of plants for utilizing increased pressures will probably become less and load factors and price of fuel will increase, which changes will affect the value of the economic pressure which can at any time be used to advantage.

Enlarged Oil Furnace Increases Efficiency

BOILER FURNACE REMODELED TO INCREASE CAPACITY AND DECREASE MAINTENANCE EXPENSE. BY FREDERICK KRUG*

MANY BOILERS in small plants are in operation, the efficiency of which could be greatly improved and the maintenance costs lowered by changes in furnace and structural details. Such changes can often be made at a reasonable cost but many engineers hesitate to make them, not knowing definitely the results that may be achieved.

Five boilers are installed in our steam plant, which is operated as an auxiliary to hydro-electric plants. Three of these boilers are rated at 510 hp. each and the original furnace settings were designed for coal firing. When the plant was converted to oil firing, it was found that the limited combustion space precluded the possibility of getting first class results from these boilers. Considerable trouble was also experienced in operation and maintenance due to the numerous tube failures and excessive baffle repairs necessary.

Study was made of three methods of increasing the capacity of the combustion space. The first method proposed was to raise the boiler several feet higher by lengthening the supporting members. This presented structural difficulties calling for the raising of the building also, and would have been rather expensive. It was also felt that the flame would still impinge on the bridge wall with consequent heavy maintenance.

The second method considered was to construct a dutch oven to extend out from the front of the boiler. This plan would provide ample space for the flame without impingement but the difficulty of constructing and maintaining an arch together with the cost, were the deciding factors against this solution. The third method was to remove the bridge wall, install baffle tile on the rear section of the lower tubes and have the boiler rear-fired. This appeared to be the most feasible and economical plan and it was decided to try it out on one boiler.

Figure 1 shows a longitudinal section of the boiler before remodeling and Fig. 2 shows the same section after remodeling.

It can readily be seen how in the original furnace setting the flames do not fill out the first pass and the front end of the tubes do not do their share of the work, while in the remodeled setting the gases have ample space in which to burn and they distribute themselves over the entire first pass, resulting in more efficient operation.

When the remodeling of the one boiler was completed it was tested under ordinary operating conditions and checked against one of the other two remodeled boilers. The results were so gratifying that it was decided to change the remaining two boilers in a similar manner as soon as operating conditions would permit.

In preparing the plans for the remodeling of these boilers considerable thought was given to a number of details each of which in itself might not affect the results much but which, collectively, would improve the layout. The general plan of the remodeled furnace increased the combustion space from 850 to 1250 cu. ft. The increase would have been even greater had it not been decided to increase the thickness of the furnace walls in the section below the tubes, from 18 to 22½ in. It was felt that the severe strain which the furnace walls must withstand with oil-fired boilers warranted the in-

*Assistant to President, Porto Rico Railway Light & Power Co.

crease in cost because of the longer life that might be expected from the walls. In that part of the walls where the flame was likely to impinge three courses of firebrick were laid in place of two elsewhere in the combustion chamber. The number of burners was reduced from four to three and they were so located that they would be 3 ft. apart and the distance from the two outside burners to the side walls was to be 3 ft. Figure 3 shows these various features.

The baffle tile used to lay over the lower tubes in the rear section to divide the combustion space from the second and third pass were simple to install. They are of the split type placed back to back and slid along the tubes into position after dipping in cement. Doubt was expressed in some quarters as to their durability, but to date they have given excellent service and have effectively sealed the second and third passes from the combustion space below.

To permit the operation of a boiler at its maximum capacity with average draft conditions generally requires in the neighborhood of 3 sq. in. of free area in checkerwork per b.hp. The original setting provided a total of only 1000 sq. in. of free area. This was increased to 1500 sq. in. in the remodeled boiler. The maximum distance of the air openings from the burners was held down to 5 ft. 2 in., since by having the air openings extended as short a distance as possible the tendency of the flame will be to hug more closely to the floor. This is particularly desirable with this type of layout, since it tends to increase the combustion space utilization.

To provide for the removal of such soot as might accumulate on the baffle tile, side dusting doors were installed, one on each side. It has been found that by means of a hand lance used occasionally this space can easily be kept clear of soot accumulation.

Cost of one complete new setting including all of the changes noted and covering the necessary relocation of piping for oil and steam, new dusting doors and buck stays, baffle tile, etc., was approximately $3500. All of this amount, however, is not properly chargeable to the remodeling, since the setting was in such condition that it would have had to be rebuilt in any event.

Results of a comparative test made on boiler No. 1 after it had been remodeled and boiler No. 2 before remodeling, are given in the table. These tests were performed under normal operating conditions throughout and with practically the same load on each boiler. Boiler No. 1 carried the load with ease and could have carried considerably more. Boiler No. 2 on the other hand had to be forced.

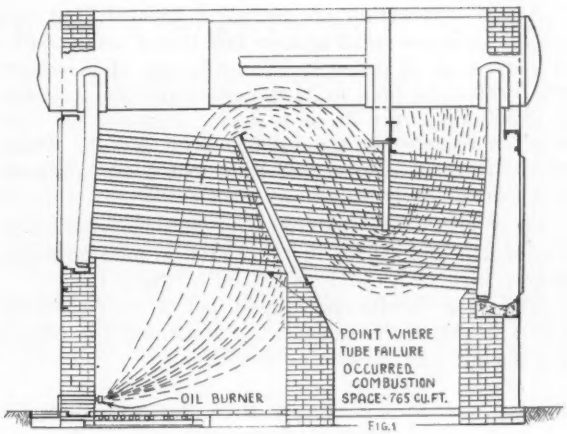


FIG. 1. SECTION OF OIL-FIRED BOILER BEFORE REMODELING
FIG. 2. REAR FIRING WITH BRIDGEWALL REMOVED AND BAFFLING REDESIGNED IMPROVED OPERATION

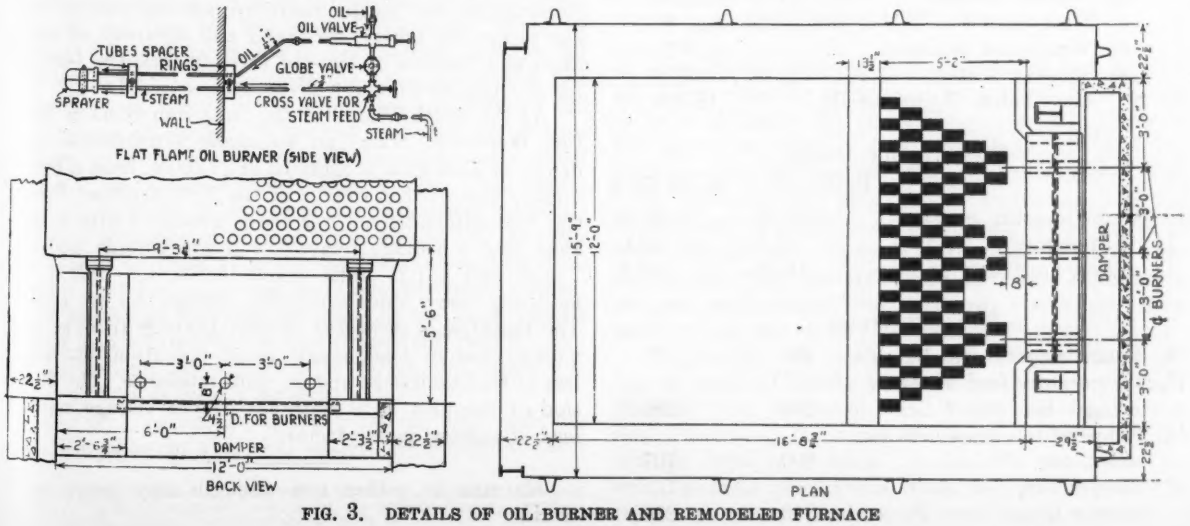


FIG. 3. DETAILS OF OIL BURNER AND REMODELED FURNACE

Actual evaporation per pound of fuel oil fired was 11.6 lb. for boiler No. 2 against 12.9 lb. for boiler No. 1, an increase of 11 per cent. The efficiency of the boiler and furnace for both units was calculated on the basis of 18,500 B.t.u. per lb. of fuel oil. Actually the fuel oil often runs to less than 18,000 B.t.u. per lb., which would bring the efficiency of boiler No. 1 up to almost 75 per cent.

On a 30-day run, the saving on the remodeled boiler is estimated at $800 for fuel and $100 in reduced maintenance with prices and conditions in Porto Rico.

These test results immediately led to the conclusion that it would pay to remodel the remaining two boilers in a similar way as soon as possible.

BOILER TEST REPORT, PORTO RICO RAILWAY LIGHT & POWER COMPANY

	Boiler No. 1	Boiler No. 2
Date of test	May 20, 1926	May 21, 1926
Location of Plant	Santurce, Porto Rico	Santurce, P. R.
Maker of boiler	Casey-Hedges 1	Casey-Hedges 2
Heating surf., sq.ft.	5100	5100

Description, Dimensions, Etc.

	Boiler No. 1—	Boiler No. 2—
1. Draft	Natural–125 ft.	Natural–125 ft.
2. Fuel	Venezuela oil	Venezuela oil
3. Boiler heating surface	5100 sq. ft.	5100 sq. ft.
4. Combustion volume.	1250 cu. ft.	850 sq. ft.
5. Air space under burners	1500 sq. in.	1000 sq. in.
6. Boiler settings (taken at boiler front deck to tubes).	7 ft. 1 in.	7 ft. 9 in.
7. Furnace volume per square foot of heating surface	0.245 cu. ft.	0.166 cu. ft.
8. Air space under burners, per burner.	500 sq. in.	250 sq. in.
9. Oil analysis.		
(a) Specific gravity	0.949	
(b) Beaumé gravity	17.5 Beaumé	
(c) Flash open	205 deg. F.	
(d) Water and sediment	0.20%	
(e) Sulphur content	2.00%	
(f) Heat value, B.t.u. per lb.	18,500	

Pressures and Drafts

	Boiler No. 1	Boiler No. 2
10. Steam pressure by gage	160 lb.	160 lb.
11. Oil pressure	87 lb.	85 lb.
12. Steam atomizing pressure.	160 lb.	160 lb.

Temperatures

14. Steam temperature, deg. F.	371	371
15. Temperature feed water entering boiler, deg. F.	200	200
16. Temperature gases leaving boiler, deg. F.	800	707
17. Temperature of fuel oil leaving heater, deg. F.	210	210

Hourly Quantities

18. Duration of test	8 hr.	8 hr.
19. Oil as fired per hour	2267 lb.	2353 lb.
20. Oil as fired per sq. ft. heating surface per hour	0.444 lb.	0.461 lb.
21. Oil as fired per burner per hour	755.6 lb.	588.2 lb.
22. Cu. ft. combustion volume per developed hp. per hour	1.39	1.01
23. Sq. in. air space per developed hp., per hour	1.66	1.19

Evaporation

24. Actual water per hour	29,302 lb.	27,352 lb.
25. Factor of evaporation	1.06	1.06
26. Equiv. evap. from and at deg. F. per hour	31,055 lb.	28,868.5 lb.
27. Actual evap. per lb. oil as fired	12.92 lb.	11.62 lb.
28. Equiv. evap. per lb. oil as fired	13.69 lb.	12.32 lb.
29. Equiv. evap. per sq. ft. boiler heating surface per hour	6.09 lb.	5.69 lb.
30. Efficiency of boiler and furnace	72.1 %	64.5 %
31. Rated capacity of boiler, b.hp.	510	510
32. Percentage of rated capacity developed	176.5	164.9

Automatic Synchronous Condenser Substations

COMPARATIVELY few installations of automatically controlled synchronous condensers have been made. With the demonstration of the reliability and practicability of such equipment its use should increase at a rapid rate. Economies resulting from this method of operation are comparable with those proven in the case of other types of automatic substation apparatus. The justification for automatic switching appears chiefly in the reduction of the attendance expense, the cheapening of the station construction, the greater insurance against serious damage to the equipment, the speed and accuracy of operation and, because of some of these factors, the feasibility of choosing the most advantageous location.

At the South Works of the American Steel & Wire Co., Worcester, Mass., an automatic synchronous condenser of 7500-kv.a. is operated at 13,800-v. from a transmission line of that voltage of the New England Power Co. The automatic controls are so arranged with a time clock and a voltage relay that if the voltage between 7 a.m. and 6 p.m. falls below 13,200, the unit automatically starts and builds the voltage up to 13,800. The machine is protected against bearing trouble, low voltage, loss of load, single phase operation, overload, loss of field excitation and current unbalance. The function of the unit is to maintain proper voltage with a load of lagging power factor.

HALTING to gather new strength may prove good tactics.

Over Fire Supplementary Air Introduction

PROPER ADMISSION OF PART OF AIR SUPPLY OVER FUEL BED IN IMPINGING STREAMS SUPPLIES MOST NEEDED AND RESULTS IN BETTER COMBUSTION. BY A. E. GRUNERT

DUE TO ECONOMIC considerations most of the coal consumed by the Commonwealth Edison Co. for power generation must come from Central Illinois fields. The general characteristics of the fuel from these areas present a serious problem, not only from the standpoint of efficient combustion but also from the standpoint of smoke abatement. We are dealing with a fuel of high moisture and ash content and with correspondingly low heat value. It is a fuel having a low ash fusing point, causing heavy slagging and clinkering; it has a high content of sulphuric acid in its products of combustion and it has a relatively high volatile content. Except for a few stray heat units it has about everything we don't want, hence its inevitable tendency to smoke, added for good measure.

LARGE COMBUSTION SPACE NOT ALONE EFFECTIVE

Except for experimental purposes with pulverized fuel the entire steam power production of our system at the present time is by use of chain grates supplied with both natural and forced draft; the latter being the practice in the newer installations. The smoke problem, in connection with the early development of the forced blast chain grate, became a matter of even more serious concern than that with the usual natural draft chain grate. Capacities, coal rates and temperatures were increased. The unusually large combustion chambers provided for these conditions, did not solve our smoke problem to the degree expected. It was clearly apparent that if efficient conditions were to be maintained some other means of controlling this situation was necessary.

That which we observe as smoke issuing from stacks may be the general term referring to it: It may be excessive fly ash or flue soot as a result of cleaning or it may be something else. But the particular brand of smoke with which we are mostly concerned is the kind that results from the dissociation of the hydrocarbon constituents of coal in the absence of sufficient oxygen for complete combustion, which causes the carbon element of these volatiles to be thrown out of the combination in the form of innumerable particles. This, of course, is known to be due to stratification of gases and uneven mixture of gases with the required oxygen, but knowledge of the situation alone has not stopped the production of smoke. A careful investigation of conditions existing in the furnace, therefore, was carried out by the Commonwealth Edison Co. The results showed that the large combustion chambers provided to allow thorough mixing of the gases did not take full advantage of their opportunities and combustion difficulties that had been vaguely suspected were verified. It is worthy of note that the basis of the improvement of our smoke situation was first proved and then checked by subsequent investigations in which the reason for the results was clearly brought out.

Figure 1 represents, in a general way, the condition of combustion in a typical modern forced blast chain grate furnace. The typical compositions of the gases arising from fuel bed at the points indicated and the composition of the gases at the different points in the first pass, are shown. The gases were sampled simultaneously at eight positions in the furnace and six at the first pass entrance by means of water cooled sampling tubes. These were inserted through the side walls of the furnace at the relative positions shown and at about 9 in. above the grate line. Each individual set

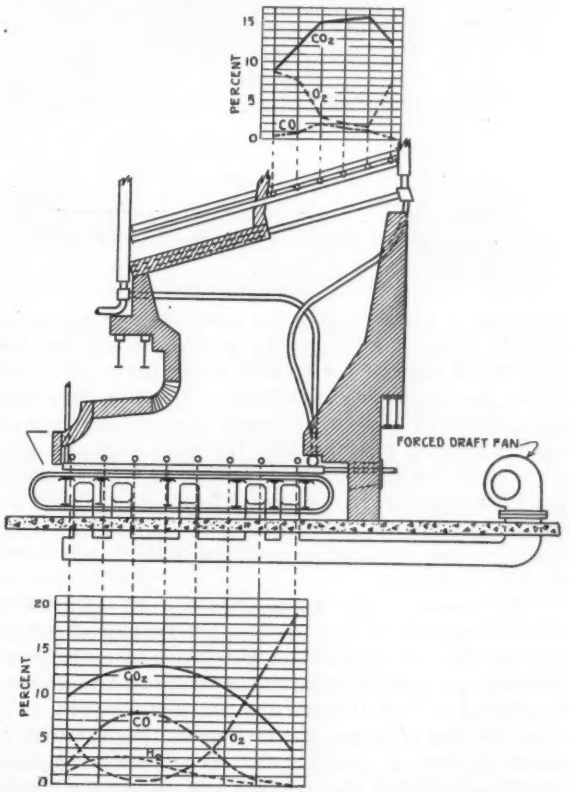


FIG. 1. TYPICAL COMBUSTION CONDITIONS EXISTING WITHOUT OVERFIRE AIR INJECTION

of samples was collected over a period of 15 min., during which time the firing conditions were held constant so as to eliminate the effect of any variable factor in the operation. During this period also, the samplers were moved every few minutes over a distance of 2 ft. from the center line of the stoker to the side line and back again. The samples obtained in this way would represent the mean analysis at that position and practically eliminate the error possible when holding the sampler continuously over a spot or streak not representative of the entire fuel bed.

In practice the passing of air through a live fuel bed of usual thickness is accompanied by both endothermic (heat absorption) and exothermic (heat evolution) reactions, the zones of which are more or less distinct from each other. A fuel bed thickness that would produce all exothermic reactions would be so thin that, with present chain grate equipment, it would be

*Efficiency Engineer, Commonwealth Edison Co., Chicago. Presented at Joint "Smoke Abatement" meeting of the Western Society of Engineers and the Chicago Section of the A. S. M. E.

impractical. A condition that in effect approaches this ideal exists at the point of initial ignition over the first chamber. At this point the ignition has not yet penetrated to any great depth and the active portion of the fuel bed is so thin that the endothermic reaction has not yet developed. This is shown by the fact that at this point there is an excess of oxygen and a low content of unburned gases. Under usual conditions the point, while quite variable, at which active reactions have penetrated to the grate, evidently lies at from 12 in. to 18 in. after leaving the stoker fuel gate, as represented at A in Fig. 2. Beyond this point the zone shown at B represents the portion of the fuel bed in which carbon

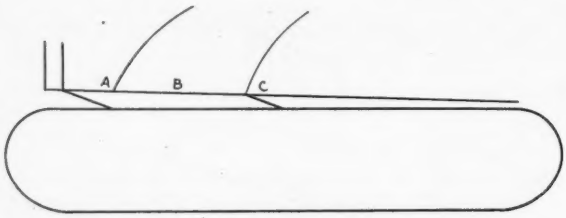


FIG. 2. DIAGRAM SHOWING COMBUSTION OF FUEL ON CHAIN GRATE

would be in excess, due to the combustion reactions involved. This zone is also the portion of the fuel bed from which most of the volatile constituents are driven off in an unconsumed condition. There is, therefore, a deficiency of oxygen necessary to complete the combustion process, accompanying the gases from this zone. At a point for instance such as C, the volatile matter has been practically all drawn off and the fuel bed has become so thin that the action would more and more approach the exothermic condition and oxygen would then be in excess.

The excess oxygen at the rear end of the grate is due to a number of circumstances besides that of leakage through the rear end of the fuel bed. In order to reduce ash pit losses to a minimum, some excess air must be allowed to flow through the last compartment. The other sources of excess air are due to the fact that no stoker is perfectly sealed against bypass air and neither can it be expected that any ash pit, as ordinarily constructed unless it is water sealed, is absolutely air tight. We, therefore, have a flow of air into the furnace in this vicinity, which, unless properly directed, will not function to any extent in actual combustion. The first pass exploration easily proves this fact with the furnace construction indicated in Fig. 1. This shows that strata of excess air streak through the pass, adjacent to the headers.

Mixing Usually Poor

While the analyses of the fuel bed gases show the cause of conditions in the first pass, it is in order now to consider what are the resulting objectionable conditions. In all cases, unburned gases are present in the first pass and the points at which they are maximum are also the points where excess oxygen is at a minimum, the uneven distribution being traceable to action of the fuel bed. The visible condition usually observed by the direct results of this situation is delayed combustion, or what is ordinarily referred to as "long flaming" tipping out at a point further on where the unburned gases have been satisfied with the required oxygen. In these tests the usual tipping out of the flame occurred at the top of the pass and sometimes as far up as the superheater.

It can readily be seen why this condition reduces the efficiency of heat absorption. The provision of unusually large combustion chambers primarily for the purpose of eliminating this condition of stratification is apparently not very effective. The flow of gases from the fuel bed is still along direct and stratified lines as subsequent investigations have shown. In other words, it is rather optimistic, from the nature of the flow of the gases, to expect gases rich in oxygen from the rear to mix with those deficient in oxygen coming from the front without introducing some other agency besides volume to cause them to do so.

The condition as represented naturally suggests the means for improving the situation. The altered conditions as a result of injecting air under pressure in

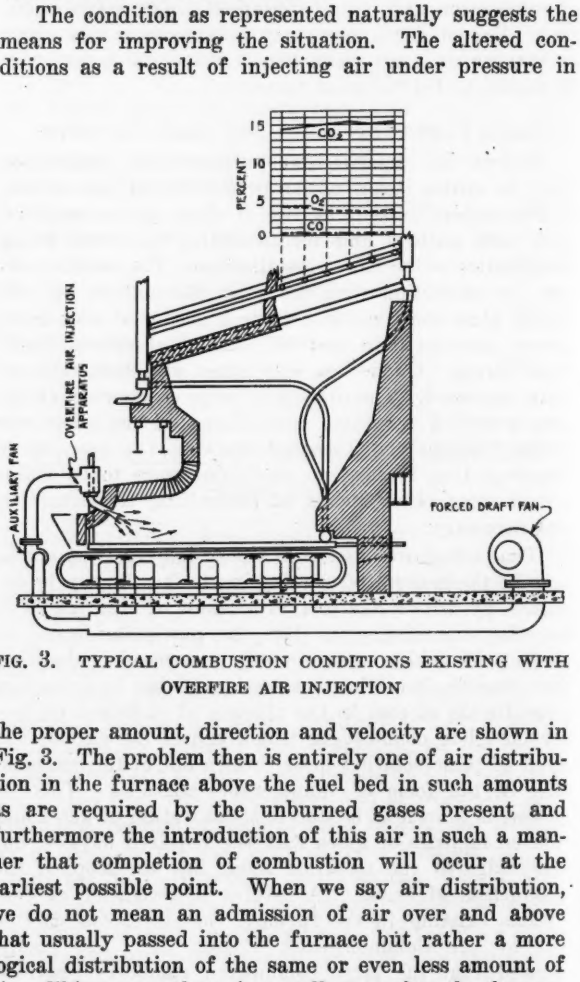


FIG. 3. TYPICAL COMBUSTION CONDITIONS EXISTING WITH OVERFIRE AIR INJECTION

the proper amount, direction and velocity are shown in Fig. 3. The problem then is entirely one of air distribution in the furnace above the fuel bed in such amounts as are required by the unburned gases present and furthermore the introduction of this air in such a manner that completion of combustion will occur at the earliest possible point. When we say air distribution, we do not mean an admission of air over and above that usually passed into the furnace but rather a more logical distribution of the same or even less amount of air. This means that air usually entering the furnace as excess, if ineffective, must be diverted to the point where it functions in combustion. These conditions naturally suggested the introduction of overfire air directly into the furnace in such a manner that the deficiency of oxygen would not only be supplied but, by pressure nozzle injection, the desired mixture could be brought about by agitation.

Accordingly a furnace such as shown diagrammatically by Fig. 3 was put into operation and under test to ascertain with what degree of success the desired conditions were obtained. The nozzles for overfire in-

jection were located in the ignition arch curtain wall with the center lines so pitched that the air would be directed at the point representing the zone in which the gases are deficient in oxygen, as determined by the gas analyses. These nozzles were evenly spaced over the whole width of the furnace, 14 in all being used.

A common plenum chamber, incorporated in the arch construction, serves all nozzles. This is supplied by two ducts connected with the main forced blast air duct. Owing to the frictional resistance of the small ducts, a small auxiliary fan was put in each plenum chamber duct to serve as a booster, thus increasing the range of control over the pressures in the plenum box air supply. This control is obtained by means of a control damper. From this arrangement it can be seen that the overfire air injection is in parallel with the stoker compartments and is desirable for an important reason, other than convenience. Inasmuch as the problem is one of proper distribution of air for combustion and not of increase in total air, the object of parallel connection is obvious. Except for minor frictional differences, the opening or closing of the plenum system does not affect the total air delivery of the main forced blast fan. The opening of the nozzles merely diverts a portion of the same air into the furnace above the fuel bed as indicated in the diagram. Having accomplished a better mixture it is then possible to reduce the main fan air supply as the need for much of the excess air has been reduced. This naturally results in higher CO_2 and improved combustion economy.

STRATIFICATION AVOIDED: EFFICIENCY INCREASED

The graph of the conditions existing in the first pass, as shown in Fig. 3, indicates the result of overfire air injection when it is supplied in proper quantity and at the proper section of the fuel bed. This condition is typical inasmuch as this graph is a composite of a large number of determinations. Among the advantages derived, therefore, from the use of overfire air injection is the shortening of the condition known as long flaming, hence the reduction of final temperatures when the heating surfaces are of the same degree of cleanliness. Combustion can be carried on with higher CO_2 without the formation of unburned combustible gases. Slag and soot deposit in the first pass is reduced as an incidental effect of reducing the long flaming. The effectual elimination of the smoke nuisance is accompanied by an actual increase in combustion efficiency instead of by a decrease which results when, as is usually the case, excess air is admitted too liberally in one way or another and without much regard to distribution requirements.

Restoring Weakened Storage Cells

THERE ARE several methods of restoring storage cells that have become low:

(1). Overcharge the whole battery until the low cells are brought up to the proper point, being careful not to damage other cells in the battery.

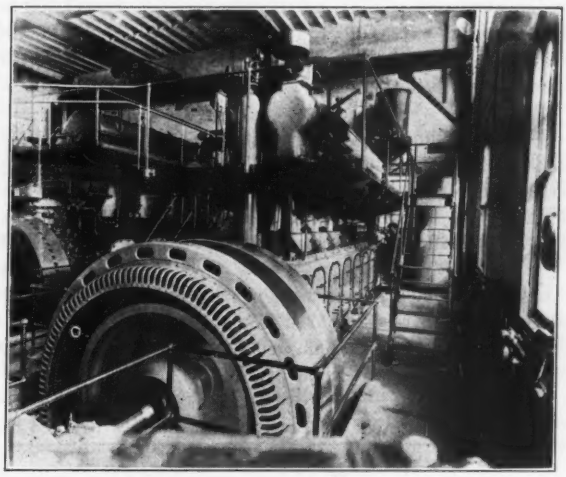
(2). Cut the low cells out of circuit during one or two discharges and in again during charge.

(3). Give the defective cells an individual charge.

Before putting a cell that has been defective into service again, care should be taken to see that all of the signs of a full charge are present.

Diesel Engine Operating Costs

INCREASING coal and labor costs caused the City of Horton, Kansas, to install its first Diesel oil engine, which was 400 hp., in August, 1921. The steam plant, which was thus replaced, was used as standby power from the time of this replacement until January, 1925, when a 562-hp. Worthington Diesel engine was installed. This latter engine was then operated continuously for 201 days and 4½ hr. When inspected at the end of this run, the engine was found to be in excellent mechanical condition except for one damaged spray valve stem, which had caused the shut-down.



DIESEL ENGINE OF 600 HP. INSTALLED AT CITY OF HORTON, KANSAS, BY THE WORTHINGTON PUMP & MACHINERY CORP.

PLANT OPERATING COST RECORD—1925

Fuel oil—144,594 gal. (24-26 gravity)	$ 6,188.67
Lubricating oil—1740 gal.	1,251.07
Repairs and extra labor	741.96
Engineers' salaries	4,360.00
One-fourth Superintendent's salary (balance charged to waterworks and distribution)	750.00
Total plant operating costs	$13,291.70
Total plant cost	$100,000.00
Total production	1,162,518 kw-hr.
Plant load factor	20.7%
Kw-hr. produced per gallon fuel	8.05
	Cents
Fuel and lubricating oil cost per kw-hr.	0.639
Repair and extra labor cost per kw-hr.	0.064
Labor and superintendence cost per kw-hr.	0.439
Fixed charge cost per kw-hr.	0.860
Total production cost per kw-hr.	2.002

Fixed charges figured at 5% interest and 5% depreciation. Maintenance is carried in the operating costs.

Reduction in power and light rates resulted in increased demand which brought about a considerable increase in load and necessitated the purchase of a third engine unit. This engine of 600 hp., which is illustrated

in the figure, was placed in service during February, 1926.

Official plant operating costs for 1925 and an official estimate of similar costs for 1926 are given herewith.

ESTIMATED PLANT OPERATING COST RECORD—1926

Fuel oil—188,000 gal. (24-25 gravity)	$ 9,400.00
Lubricating oil—1800 gal.	1,300.00
Repairs and extra labor	1,000.00
Engineers' salaries	4,360.00
One-fourth superintendent's salary	750.00
Total plant operating costs	$16,810.00
Total plant cost	$150,000.00
Estimated total production	1,700,000 kw-hr.
Plant load factor	18.6%
Kw-hr. produced per gallon fuel	9.04
	Cents
Fuel and lubricating oil cost per kw-hr.	0.629
Repair and extra labor cost per kw-hr.	0.050
Labor and superintendence cost per kw-hr.	0.300
Fixed charge cost per kw-hr.	0.882
Total estimated production cost per kw-hr.	1.861

The estimate shows that the cost per kilowatt-hour is expected to be less than in the previous year, even with an added investment of $50,000.00, due entirely to increased load. With a higher load factor, this record could be still further surpassed.

15,000-HP. Diesel Engine Tested

RESULTS of acceptance tests made on the engine generating set furnished to the Hamburg (Germany) Electricity Works by Messrs. Blohm and Voss are published in Engineering of London, England. Five

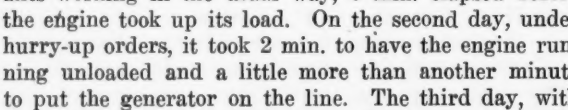


FIG. 1. SPEED VARIATION WITH ENTIRE LOAD THROWN OFF

points were to be determined: starting time, speed regulation when load was suddenly thrown off, fuel consumption, lubricating oil consumption and behavior of engine when overloaded.

As to starting time, on the first day, with attendants working in the usual way, 8 min. elapsed before the engine took up its load. On the second day, under hurry-up orders, it took 2 min. to have the engine running unloaded and a little more than another minute to put the generator on the line. The third day, with the usual operating conditions, starting was accomplished in 5 min. and 15 sec.

To test the ability of the governor to handle abrupt load changes, with the engine running at 94 r.p.m. under full load, the whole load was suddenly thrown off. Figure 1 shows the record of the speed changes, speed rising rapidly by about 14½ per cent, then decreasing slowly, with a second short rise and a final settling back to 94 r.p.m. Normal speed was restored within 32 sec. Other tests made by throwing off half load showed satisfactory results.

In the test for fuel consumption, readings were taken every 5 min. during the first full load test, and afterward were taken every 2 min. Electric output was measured first with the meters of the plant showing kilowatt-hours, second by precision instruments, installed for this purpose. Generator efficiency calculations were made by representatives of Messrs. Siemens-Schuckert, from values of load, temperature and power factor. Fuel consumption was ascertained in two in-

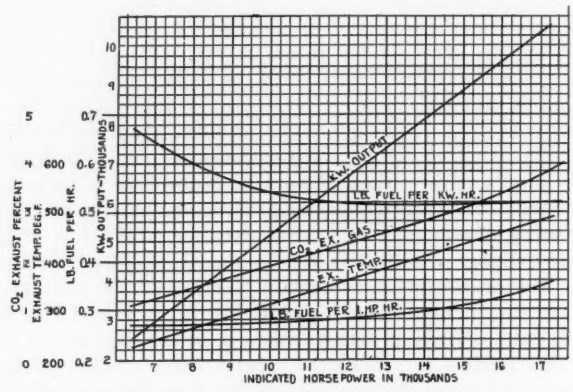


FIG. 2. RESULTS OF TESTS OF FUEL CONSUMPTION ON DIESEL ENGINE

dependent ways, by a Siemens disc meter and by standardized fuel tank, the two methods being found in agreement within ½ of 1 per cent. Fuel used was an oil to specific gravity 0.875 at 59 deg., firing point 201 deg., calorific value 18,018 B.t.u. per lb.

Fuel consumption tests were run for 3 hr. at full, ¾, ½ and ¼ load, the measurements being taken only during the last 2 hr. after steady conditions had been ascertained. Fuel consumption results are as given in Table I but these weights do not include the oil re-

TABLE I. FUEL CONSUMPTION TEST, 15,000-HP. DIESEL ENGINE

Load Per cent of Full	M.E.P. Lb. per Sq. In.	Ind. HP.	Comp. HP.	Blower Motor KW.	Generator KW.	Fuel per Hr.-Lb. Per I.HP.	Fuel per Hr.-Lb. Per KW.	Ex. Temp. Deg. F.
100	79.6	17,370	1190	565	10,405	0.360	0.521	550
100	80.0	17,450	1206	572	10,446	0.355	0.519	545
0.75	64.8	14,120	1190	570	7,941	0.298	0.516	428
0.50	48.0	10,460	1101	556	5,417	0.273	0.528	322
0.25	29.3	6,400	1035	570	2,561	0.269	0.673	221

quired for the scavenging air blowers which had, at all loads, to deal with the same amount of air, namely 1825 cu. meters per minute. The air pressure was about 1.73 lb. gage at the engine. Mean energy absorbed by the scavenging motor at 85-per cent power factor worked out to about 770 hp., of which 42 hp. was lost due to the speed being reduced to 2800 r.p.m., whereas full speed was 3000 r.p.m. Energy required by the air was about 725 hp., or 4.85 per cent of the effective engine power.

Including fuel for scavenging, the consumption of the engine amounted to 0.392 lb. per electric hp. at full load; fuel consumption at ¾ load was 0.387 lb. per

electric hp. and at ½ load showed 0.412 lb. The fuel consumption would have been smaller, if scavenging air had been adjusted to the actual amount needed under different conditions.

As to mechanical efficiency, on full load tests the mean indicated pressure was found to be 80 lb. per sq. in., speed 94 r.p.m., indicated hp. 17,450, effective electric hp. 14,640, no load hp. 2810, scavenging power 728 hp.; this gives the mechanical efficiency, neglecting the blower, of 0.84 and with the blower of 0.80.

Consumption of lubricating oil for the cylinders and compressors was found to be 18 lb. an hour. Length of the trials was hardly sufficient to determine separately the lubricants consumed by the gearing, but previous measurements gave an estimate of 5½ lb. an hour, so that total consumption of lubricants would be 23.6 lb. an hour, or equal to 0.015 lb. per electric hp. per hour.

TABLE II. THERMAL BALANCE AT FULL LOAD, DIESEL ENGINE

Heat supplied in fuel	100.0%
Heat lost in cooling water	26.0%
Heat lost in exhaust and radiation	29.2%
Heat lost in friction	4.2%
Heat equivalent of output	35.7%
Heat equivalent of blower power	1.8%
Heat equivalent of compressor power	3.1%

Runs for short periods at overload of 5 per cent and of 10 per cent showed no trouble of any kind, the engine running at all times quietly and steadily, without smoke, except that a little light gray smoke appeared during excess loads.

As a result of the test, the engine has been accepted by the Hamburg Electricity Works and put into service.

THE UNITED STATES CIVIL SERVICE COMMISSION has just issued an interesting pamphlet which describes the work of engineers in the Federal executive civil service. There are more than 3000 civilian professional engineers in the employ of the government.

Federal engineering operations are carried on in every part of the United States and extend to Alaska, Guam, Hawaii, Panama, the Philippine Islands, Porto Rico and Samoa. The activities of the government engineering force embrace practically every branch of endeavor to which engineering is applied and many branches of the service offer unique training to engineers since many of the research studies carried on are not duplicated in private industry. The contacts made by young engineers in the government service are exceptionally valuable. Salaries obtained by government engineers upon entering private industries are a striking testimonial of the recognized value to the training and experience which the Federal service offers. The salaries in the service for junior engineers at Washington range from $1860 to $2400 a year. Promotion through the successive grades is made to positions paying $7500 or more a year. Persons who desire to be notified of the announcement of examination of any grade or in any specialty may place their names on file for that purpose with the United States Civil Service Commission, Washington, D. C., which will be glad to send a copy of the above pamphlet No. 2599 to anyone interested.

How Sludge Is Formed in the Oil Pans of Gasoline Engines

BY G. S. HAMILTON*

OCCASIONALLY gasoline engine users have been misled into thinking their oil, from its appearance on a bayonet gage or otherwise, was in excellent shape because it appeared quite thick and rich. If at any time the oil in the crankcase gives the appearance of being heavier than it was when new, sludge may be expected to have formed.

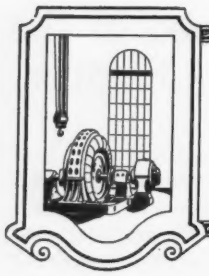
Sludge is a mixture of water, oil, fuel and dust. Clean oil and water will not mix permanently. Vinegar and salad oil will not mix, for instance, but the addition of the yolk of an egg, salt, pepper, etc., in proper proportions and in the right order, will produce mayonnaise—an excellent example of a permanent and stiff emulsion.

If any sludge formations are found, it must be that water has found its way into the crankcase. Some slight amounts may enter in the form of vapor by way of a breather pipe, to be condensed against the cold metal. By far the greater amount, however, comes from the combustion chamber in the following way: Gasoline is a chemical combination of hydrogen (H) and carbon (C). Gasoline burns in air, and by "burning" we mean combining with oxygen (O). The carbon in the gas unites with the oxygen to form CO_2, carbon dioxide —a gas which escapes with the exhaust. But the hydrogen in the gasoline unites with the oxygen to form H_2O —water. Of course, this water is in the form of steam, but, when the engine is cold, the metal parts, before they have become heated, serve to condense this steam in the combustion chamber. It takes the form of minute drops which, under the action of the piston, are beaten up with the oil film on the cylinder walls and, as this film is being continually replaced with oil from the crankcase, the water laden oil is readily transferred to the crankcase, where it is whipped up with the oil supply by the action of the connecting rods. Sludge—thick, heavy, black and slimy—is the result. It may cause much trouble, particularly if the mesh of the screen at the oil pump is fine, in which case the sludge will cover it and cause it to be broken by the vacuum created by the pump—or with a less positive pump action, the oil supply will be cut off, causing the bearings to be burned out.

If sludge is believed to have been formed, the oil pan should be dropped and this, as well as the accessible interior parts of the engine, thoroughly cleaned. A lintless cloth should be used for this purpose. At no time should water be used. Sludge has the peculiarity that, when once formed, a small quantity of it which may have been permitted to remain, will promote its further formation when fresh oil is added. This action seems to be, so to speak, infectious.

*Climax Engineering Co., Clinton, Iowa.

THE MAN WHO keeps and works with a desk in a clogged up condition is in just as bad health, from a business point of view, as one with his physical body in such a state. It's mighty inefficient and strangles incentive!



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Automatic Substations for Industrial Plants

REDUCTION IN ATTENDANCE CHARGES AND ELIMINATION OF THE INEFFICIENT OPERATOR HAZARD ARE ONLY TWO OF SEVERAL ADVANTAGES OF AUTOMATIC EQUIPMENT. BY E. L. HOUGH*

AUTOMATIC SWITCHING equipment is finding an increasing field of usefulness in supplying power requirements in industrial plants of every description. Control devices and schemes which have been developed for automatic railway and central station substations have been found to be admirably suited to the requirements of industrial substations with almost no alteration. Engineers in the electric railway and central station fields have found that their study of power distribution and substation problems is incomplete unless they carefully consider automatic control of their equipment.

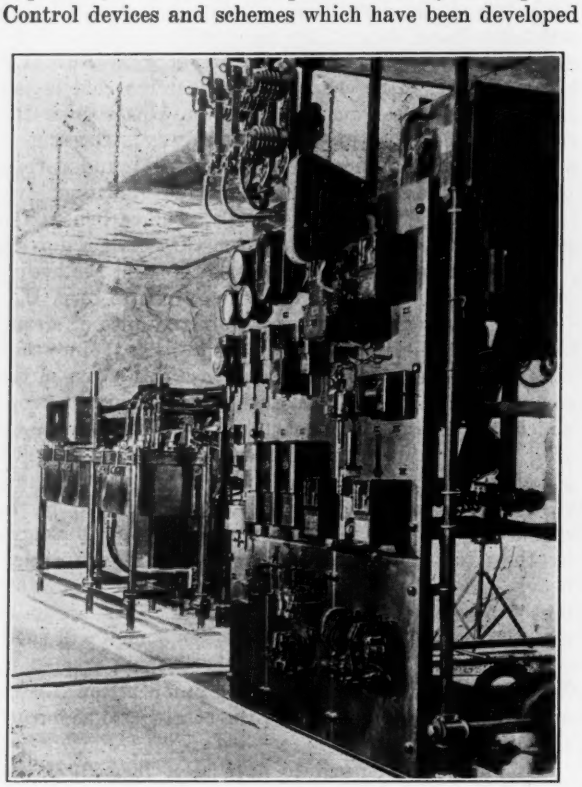


FIG. 1. MINING TYPE OF AUTOMATIC SUBSTATION IN A SALT MINE. RETSOF MINING COMPANY, RETSOF, N. Y.

The advantages of the automatic substation have been discussed in detail in various electrical publications and no attempt will be made to outline them in detail here. The benefits which will accrue by the installation of automatic control vary with the circumstances of the particular case under discussion and, in each of the following descriptions, some of the advantages gained in each case will be given. It has been found that automatic substations make possible savings in one or more of the following ways:

(1) Reduction in attendance charges.
(2) Elimination of the inefficient operator hazard.
(3) Reduction in maintenance charges.
(4) Reduction in feeder losses.
(5) Reduction in number and duration of "outages" with consequent reduction in spoilage of material in process and in loss of production.

THE MINING INDUSTRY

By far the largest number of automatic substation installations in the industrial field have been made in mines. In this class of service the units are small (rarely over 300 kw.), and the load is scattered. The trolley voltage is usually not over 275 v. on account of safety considerations and this results in excessive feeder drop and loss if the direct-current power is transmitted for any considerable distance. The small size of units entails heavy attendance charges if attendants are provided for each unit and if the units are located where they should be to supply the load economically. Consequently, the practice of locating conversion units where there are operators who have other duties rather than at the load center has developed. This results in poor voltages at the working faces, consequently the mining industry is carrying an unnecessary financial burden entailed by the excessive feeder losses, and an appalling number of armature burnouts caused by overloading motors at low voltage. Elimination of the operator by the installation of automatic control has made possible the location of substations at load centers without regard to the availability of operators and has brought with it a reduction in overall power costs.

All types of mines have made use of automatic substations in one way or another. Installations in the bituminous mining industry are too numerous to mention and quite a considerable number have been placed in service in anthracite collieries. Such equipments are in use in the iron and copper mines and a rather extensive installation is soon to be made by a nitrate property.

One interesting equipment of the mining type (Fig. 1) has been installed in a salt mine. This control is

*General Electric Co.

located in a room cut out of the salt at the working level, 1100 ft. underground. Power is supplied to the substation by a lead covered cable at 2300 v., 25 cycles, a.c., and converted by a motor-generator to 275 v., d.c. The set is started by closing the oil circuit breaker in the line which feeds it either at the shaft bottom or from the surface as desired. If (as indicated by the control devices) the set is in condition to run and the line conditions are normal, the set is connected to the line through a compensator. When synchronous speed is reached, the motor field is excited and the motor is disconnected from the compensator and connected directly to the line. The generator is next connected to its load by a "feeling-out" equipment which prevents closing the generator on a load which is in excess of its rating. Protection is afforded at all times against hot bearings, machine overspeed, a.c., overload, machine overheating, low a.c. voltage, d.c. overload, reverse-power, etc. In brief, the automatic control does what an exceptionally alert operator would do at a speed which he could not expect to equal and with a certainty of operation and protection not ordinarily attained by an operator. At this mine the salt is shot down by dynamite and, as a safety measure, all power is cut off of the mine while the men are connecting their shots to the trolley. When everyone is out of the mine, the automatic station is started by closing the oil circuit breaker on the surface and, as soon as the detonation is heard, the unit is shut down. This gives an extremely high factor of safety and is an inexpensive method of reducing the risk usually attending such work.

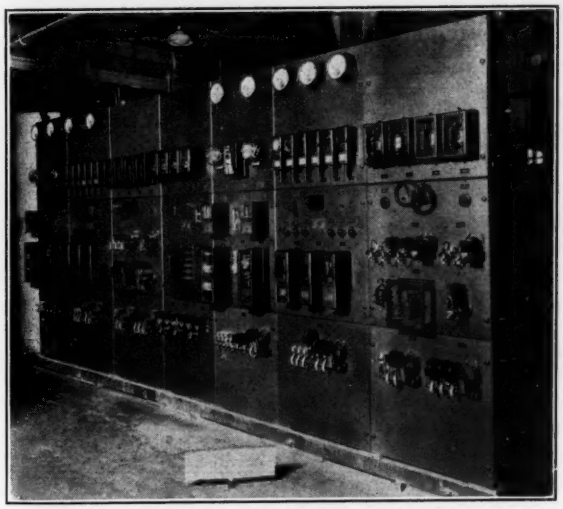


FIG. 2. AUTOMATIC CONTROL EQUIPMENT FOR TWO MOTOR-GENERATOR SETS. COMMONWEALTH STEEL CO., GRANITE, ILL.

Paper Products Factory

The Dennison Manufacturing Co., a paper specialty factory, was faced with a power shortage in 1922 and found the solution of the problem with automatic control. Power was formerly supplied by one 150-kw. and two 350-kw. steam engine-driven generators. Since considerable exhaust steam was required for process work, this arrangement provided a satisfactory and economical power supply for the plant. Additional process steam not being required, a study was made to determine the best means of increasing the power supply. Water was not available for condensing so the most economical method was found to be a 330-kw. synchronous converter and purchased power. Accordingly the converter and full automatic control were installed and an automatic induction voltage regulator used to insure satisfactory parallel operation of the engine-driven generators and the converter—the voltage of the battery being subject to variation caused by fluctuations in the a.c. supply circuit. Automatic control equipment was used to make an increase in the number of station attendants unnecessary. This installation proved so satisfactory that the need for additional power to supply the improved illumination system was met in 1925 by the use of a similar automatically controlled 330-kw. converter.

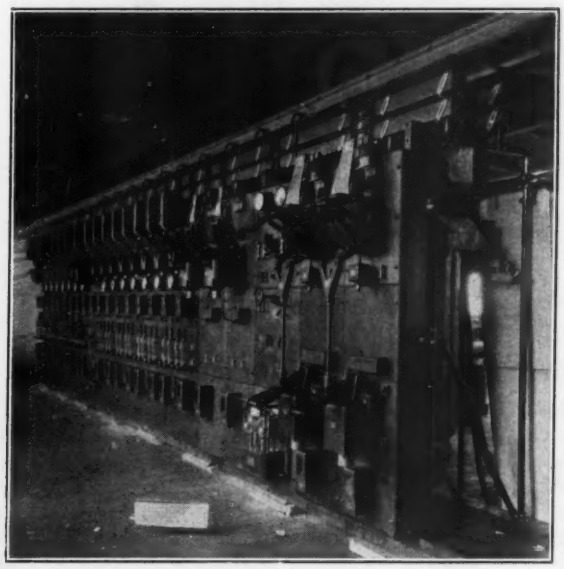


FIG. 3. MACHINE CIRCUIT BREAKERS AND AUTOMATIC RECLOSING FEEDER EQUIPMENTS FOR STEEL MILL SERVICE. COMMONWEALTH STEEL CO.

Steel Mills

Until recently there have been few installations of automatic substations in steel mills, but the number of equipments now being installed or on order indicate that the steel plant engineers are fully alive to their advantages. In this type of service maximum continuity is usually of primary importance and, accordingly, the control equipments are laid out with this end in view. Also the control must be as simple as possible to permit strength to stand considerable abuse.

The Commonwealth Steel Co. is now installing at its Granite City plant a full automatic substation consisting of one 1800-kw. motor-generator, automatic control, equipment for the sets and 17 automatic reclosing feeder equipments (Figs. 2 and 3). The scheme for starting the sets is very similar to the mine equipment already described, the motor being started through a compensator. When the set is ready to take load it is balanced on the bus automatically and the load regulating equipment makes the machine take its share of the load. This

is accomplished by a combination of voltage and current-regulating relays which control a counter-e.m.f. generator whose armature circuit is connected in the shunt field circuit of the main generator.

The regulator and relays cause the machines to balance the load in proportion to their ratings and hold constant bus voltage unless the load is beyond the capacity of the machines. In such a case the current-regulating relays limit the current output to a definite value and the voltage accordingly falls off. This permits the station to ride through peak loads which are temporarily beyond its capacity and prevents interruptions to service such as might occur in manual operation.

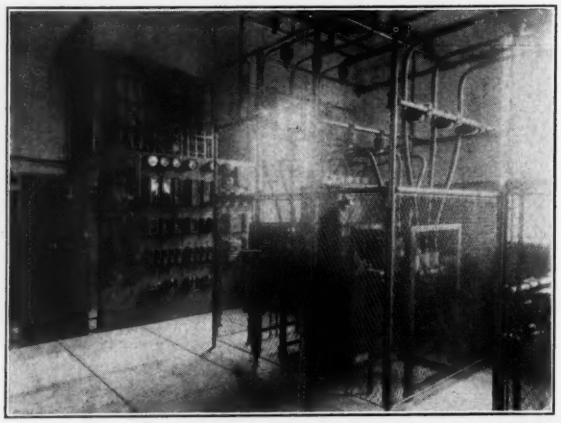


FIG. 4. AUTOMATIC SWITCHING EQUIPMENT FOR 7500-KV.A. SYNCHRONOUS CONDENSER AT THE SOUTH WORCESTER PLANT OF THE AMERICAN STEEL & WIRE CO.

The regulating equipment is very rapid in operation and, for this reason, readily handles loads which may be applied or removed suddenly and which might not be satisfactorily handled by a slower type of regulator such as a motor-operated rheostat. The automatic reclosing feeder equipments are arranged to trip on short circuit only. This is accomplished by a "rate of rise" tripping scheme. Reclosing occurs only after the expiration of a definite interval and after the load has decreased to a safe value. This arrangement provides the maximum continuity of service on the feeders. One of these circuits feeds ladle handling machinery in the foundry and further to decrease the possibility of an interruption on this circuit, provision is made for supplying this feeder from the station bus or from another station by means of a tie feeder.

Practice of starting large motors automatically is growing. This seems to result from a desire to eliminate the possibility of an operator's making a mistake resulting in damage to the apparatus. Most controls of this type are arranged to start automatically when the machine operator pushes a button. The Ford Motor Co. has installed such a control for the motor-generators supplying power to a merchant mill and to the mill auxiliaries. One button starts the sets and a second control handles the mill motor and generators which are tied together directly.

Industries which purchase their power are frequently able to secure a much more favorable rate if they maintain their power factor at a certain value. In some cases industrial plants that generate their own power also find it very advantageous to raise their power factor. In either case synchronous condensers are of value and it frequently happens that the attendance charges for operating the condenser offset the savings which would accrue. Automatic control, by eliminating the operator, makes the installation of a condenser profitable in such cases. An example of such an installation is the 7500-kv.a., 13,200-v. synchronous condenser at the South Works of the American Steel & Wire Co. at Worcester, Mass. (Fig. 4). This unit is arranged to start when the system voltage is low, and to shut down when the voltage is high and the load on the condenser is light. A time switch is used in order to operate the condenser during the day only.

Plant Lighting Substations

From time to time industrial engineers are called upon to solve problems not directly connected with the plant itself. Such a problem was recently put up to the engineers of the McKinney Steel Co. at Cleveland and was solved in a very satisfactory manner. A new office building in which were to be located the general offices, drafting rooms, etc., was to be built on the mill site and the only power available was 25-cycle power from the mill which was not satisfactory for illumination and for various variable speed motors driving ventilating fans,

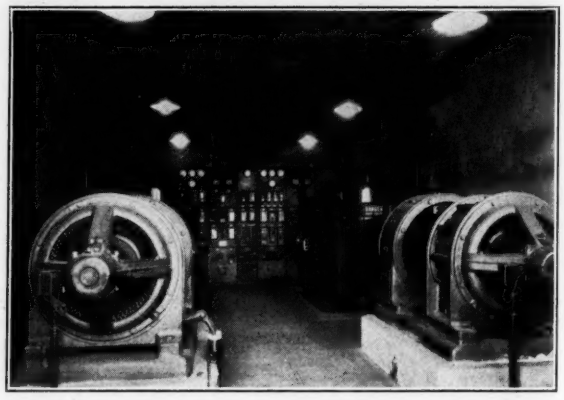


FIG. 5. AUTOMATIC SUBSTATION FOR SUPPLYING OFFICE BUILDING, MCKINNEY STEEL CO., CLEVELAND, OHIO

etc. In this case two automatically controlled 100-kw. units were installed in a basement room (Fig. 5). Slow speed sets were used to cut down noise; induction motors and three-wire generators being used for simplicity. Normally one machine, started by a pushbutton in the building, can carry the entire load but, in case it becomes overloaded, the second machine will be started and paralleled with it. Likewise, if the first unit should be shut down by a hot bearing or similar cause, the second unit will be started. Load regulating equipment makes the sets non-overloadable. In this case a very satisfactory source of d.c. power was made available without attendance charges, and these would necessarily be a good share of the total power bill where such small units are involved.

Computing Power Losses in Transmission Lines

Showing a Method of Calculating the Mean Annual Current with a High Degree of Precision. By Fred C. DeWeese

IN MAKING an investigation for determining the advisability of installing a synchronous condenser for power factor correction and voltage control, in any particular case, it is necessary to know, before a decision can be rendered, the approximate amount of power loss in the lines and transformers from which the load or loads are supplied.

The term "Power Loss," used throughout this paper, refers to copper losses alone, as these are the only losses that are materially affected by the operation of a condenser.

It is necessary, in most cases, when problems of this nature are to be solved, to make assumptions relative to certain conditions, such as power factor, load factor, etc., at one or more places along the line at which loads are supplied. It is also necessary, many times, to compare conditions at certain places with conditions of a similar nature at other places. Great care should be exercised in making comparisons and assumptions and these should be carefully scrutinized by an engineer who has had wide experience in this kind of work.

Computing power loss is quite a different problem from computing voltage drop, as formulas and methods for this work are not so well developed and it also requires a great deal more time and labor, if the final result is to be of any great value. The common error in this line of work is to make the assumption of too high a mean annual current, thus making losses appear higher than they really are.

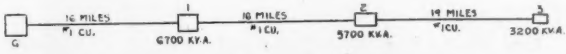


DIAGRAM OF TRANSMISSION LINE SHOWING VALUE OF LOAD AT DIFFERENT POINTS

Where the problem calls for computing the losses in a line, from which there is more than one load supplied and daily log sheets, showing the current readings are not available, the solution becomes somewhat more involved and the purpose of this paper is to illustrate a method which the writer uses and which has proven to be more accurate than any of the other methods most commonly in use.

A case will be described of a 60-kv. line, serving three different loads, as shown by the sketch.

G indicates the location of the generating station, with respect to the other stations. Station 3 is 51 mi. from G.

The loads as shown above do not indicate the loads served at the various places, but the load on the line at that place. For example: the load of 5700 kv.a. is the load at station 2 plus the load at station 3.

The following represents a solution to a problem for determining whether a condenser installation would be advisable at station 3, for improving the power factor and voltage regulation; that is, it represents a solution, as far as power losses are concerned. There are several other factors entering into the complete solution, such as, annual operating cost of the condenser, fixed charges on the investment, increased load carrying capacity of the line and transformers, etc.; however, the purpose of this paper is to show the method of computing the losses and the other questions will not be discussed.

In this particular problem, the loads are all of a similar nature and it is assumed that the power factor, load factor, etc., are practically the same at each place.

For the purpose of computing power losses, we are concerned only with the current readings and these were available only for station 3.

TABLE I

	CURRENT IN AMPERES																	
	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	
MAY	18	21	229	78	89	55	41	19	95	73	26							
JUNE	18	55	185	135	75	40	42	21	65	63	21							
JULY	35	95	195	125	79	50	44	24	43	44	10							
AUG.		20	269	120	88	66	54	35	36	43	8							
SEPT.	30	10	110	90	75	85	48	50	42	37	29	15	21	13	46	19		
OCT.	30	10	84	30	112	64	53	33	43	30	28	16	62	60	78	11		
NOV.	7	7	107	23	70	85	50	31	52	26	34	12	57	56	81	19	4	
DEC.	19	15	125	25	81	74	47	33	35	18	32	31	61	54	72	20	2	
JAN.	33	21	98	18	150	54	48	27	35	32	25	44	48	62	43		6	
FEBR.	58	20	46	6	119	54	49	33	49	15	29	34	72	42	39			
MAR.	70	34	56	59	75	45	70	43	46	52	63	23	61	32	13			
APR.	16	13	178	87	59	61	67	28	40	65	80	18	11					
	334	321	1682	796	1072	733	613	377	583	503	385	190	395	325	372	69	12	

From these readings, Table I was compiled. This table shows opposite each month the number of hours in that month, that the value of current shown above, was flowing in the line. The values at the foot of the table, under each column, represent the sum of the values for each month, or the total for the year. From these values the mean annual current is computed.

After the foregoing tabulations have been made, which does not require a great deal of time, it is only necessary to do some slide rule work, to determine what percentage of time each value of the current was flowing over the line, from which the mean annual current may be derived and from this the annual losses are computed.

In order to illustrate the method better, the work is carried out as follows:

Compute the time for each value of the current, by dividing that value by 8760, the number of hours in a year. For example: 334/8760 = 0.0381, or 3.81 per cent of the time. Using the same method for each of the other current values, arrange the work in tabulated form as shown by Table II.

The square root of the sum of each current value squared, times the corresponding value of time, will equal the mean annual current. This work is carried out as shown in Table III.

The total equals 114.7502 + 190.9096 = 305.6598

The square root of 305.6598 equals approximately 17.5 amp., which is the mean annual current flowing in the line between stations 2 and 3.

There are other methods by which the mean annual current can be determined, but if the results are to be of any great value, it is necessary to know this value

within a very close approximation, for the losses are proportional to the square of the current and a small difference either way will materially affect the final result.

The resistance of No. 1 copper is 0.6995 ohms per mile, at 25 deg. C. Then the resistance for 19 mi. is $19 \times 0.6995 = 13.29$ ohms. The loss in the line between stations 1 and 2 equals

$$(17.5)^2 \times 13.29 \times 3 \times 8760 = 107{,}150 \text{ kw-hr.}$$

As the maximum current of 36 amp. was flowing for only 12 hr. in the year, this value will be considered as negligible and the value of 34 amp. taken as the maximum. In this case, the mean annual current will equal $17.5/34 \times 100 = 51.47$ per cent of the maximum.

TABLE II

AMP.	TIME	AMP.	TIME
5	3.813	20	6.654
6	3.663	22	5.740
8	19.200	24	4.394
10	9.085	26	2.167
12	12.256	28	4.485
14	8.365	30	3.710
16	7.000	32	4.245
18	4.302	34	0.0079
		36	0.0014

The load on the line at station 2, is 76 per cent greater than at station 3, therefore, the maximum current at that point is $34 \times 1.76 = 59$ amp. The mean annual current is $59 \times 0.5147 = 30$ amp.

The resistance for this section of the line is $0.6995 \times 16 = 11.19$ ohms. The annual loss is

$$(30)^2 \times 11.19 \times 3 \times 8760 = 264{,}700 \text{ kw-hr.}$$

TABLE III

AMP.							
5^2	x	0.0381	=	0.9550	22^2	x 0.0574	= 27.8300
6^2	x	0.0366	=	1.3176	24^2	x 0.0394	= 25.3440
8^2	x	0.1920	=	12.2880	26^2	x 0.0217	= 14.6692
10^2	x	0.0905	=	9.1000	28^2	x 0.0448	= 35.2016
12^2	x	0.1226	=	16.2000	30^2	x 0.0371	= 33.3900
14^2	x	0.0836	=	16.4052	32^2	x 0.0425	= 43.5180
16^2	x	0.0700	=	17.9200	34^2	x 0.0079	= 9.1324
18^2	x	0.0430	=	13.9644	36^2	x 0.0014	= 1.8144
20^2	x	0.0665	=	26.6000			
				114.7502			190.9096

The load at station 1 is 2.086 times as great as station 3, the maximum current being $2.086 \times 34 = 72$ amp. $72 \times 0.5147 = 37$ amp. for the mean annual current. The loss in this section equals

$$(37)^2 \times 11.19 \times 3 \times 8760 = 402{,}650 \text{ kw-hr.}$$

The full load copper loss in the transformers, at the generating station is given as 0.8 per cent. The full load rating of these transformers is 7500 kv.a. The copper loss at full load is then, $7500 \times 0.008 = 60$ kw. As the copper losses are proportional to the square of the load, the mean annual load being 37 amp., the annual loss is then

$$60 \times (37/72)^2 \times 8760 = 139{,}250 \text{ kw-hr.}$$

The total losses are summed up as follows:

	90,250
	264,700
	402,650
	139,250
Total annual loss	896,850 kw-hr.

Pacific G. & E. Co.'s 1926 Construction Work

PLANT EXTENSIONS, NEW LINES AND ADDITIONAL SUBSTATIONS BUILT TO MEET GROWING DEMANDS

NORTHERN California demanded much of the power industry in 1926 and got it. Responding to the call and anticipating the needs of every community in its territory, the Pacific Gas & Electric Co. built new dams to store mountain waters, increased the capacity of generating plants, started new power projects, strung new transmission lines, reared the world's tallest transmission tower, erected substations and added costly electrical equipment. By New Year's Day the lump sum for such construction and improvement reached $19,000,000.

One of the big jobs of the year was the completion of the work of raising the rock restraining wall of Lake Fordyce, great storage reservoir far up in the mountains of Nevada County. The job cost $1,650,000, much of which was charged to previous years, as the work ran through three of the short seasons between snows.

Another dam, 80 ft. high, designed to provide more water for De Saba and Centerville power houses, was built across Philbrook creek in less than six months at a cost of $255,000.

The dam for Pit 4, next link in the company chain of Pit River power developments, was started and is now well under way. With 5 mo. of construction still to come, the total cost is estimated at $1,740,000.

Work was begun on two big projects. One calls for the building of a $2,500,000 power plant at Melones, which will draw its water supply from the dam built by the Oakdale and South San Joaquin irrigation districts. The other and larger—the Mokelumne project—includes a dam at Salt Creek, a 47,000-hp. generating plant on Tiger Creek, and revamping and enlargement of Electra power plant.

Two new substations, J and L, were built in San Francisco and equipped, one costing $308,000 and the other $250,000. Additions to new Martin substation, terminal of all the hydro power transmitted up San Francisco peninsula from the big substation at Newark, cost $721,000. More than a quarter of a million dollars was spent in doubling the capacity of Substation I, which provides commercial service for a busy district in San Francisco. At Station A in San Francisco, the big steam-electric generating plant in the Potrero, many improvements and additions were necessary to take care

of increased demands. That work required an expenditure of $300,000.

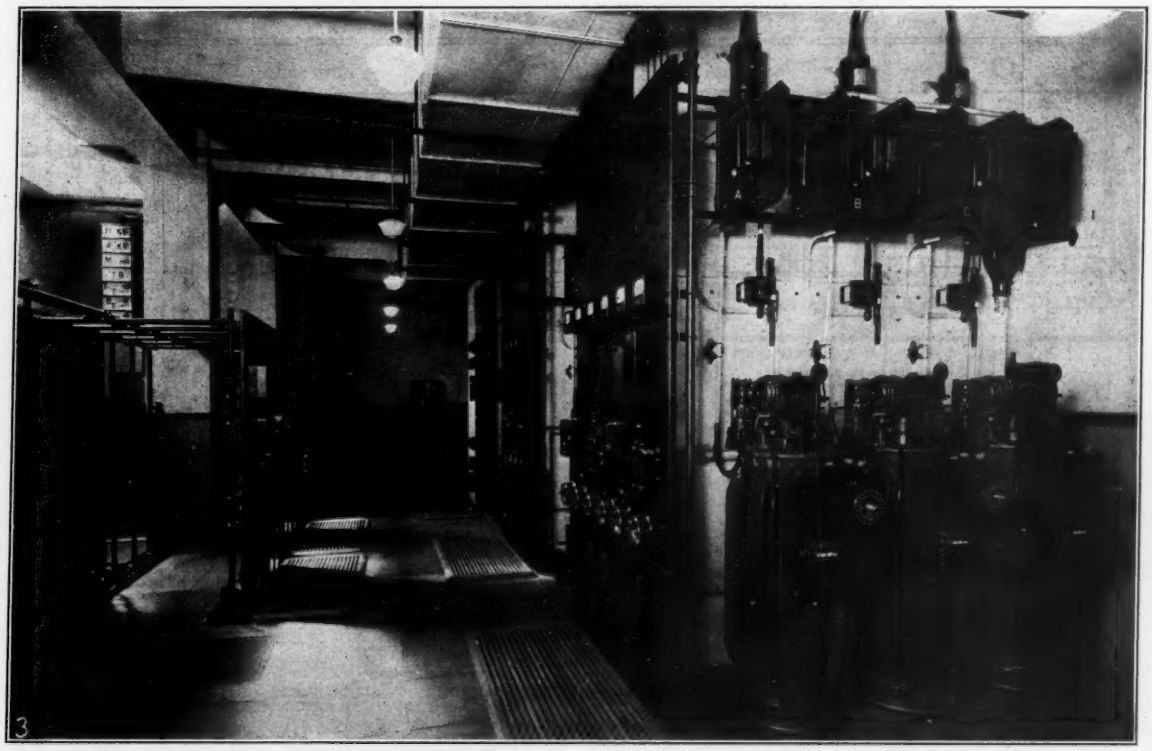
In the East Bay Division the new Substations I and E in Oakland were completed at a total aggregate cost of $766,000. Reconstruction of Substation H in East Oakland took $260,000 more. Then there were two other new substations built in Oakland, L, on which $733,000 was spent, and D, the bills for which totaled $575,000.

Contra Costa substation, near Antioch, was completed and is now receiving Pit River power transmitted from Vaca-Dixon terminal over a newly constructed line, and helping in the work of supplying current to the ever-increasing number of homes and factories of East Bay district. The cost was $600,000.

In Shasta division the new substation near Cottonwood, which takes power at 220,000 v. from the Pit River-Vaca Dixon lines and ties in with the California Oregon Power Co. system at 110,000 v., was put into operation. The total cost was $524,000.

Thirty-five miles of transmission line were strung from Vaca-Dixon to the new Contra Costa substation. This line runs through the island country north of Antioch. There the cables are supported by exceptionally high towers, one of them at the Sacramento River crossing rising 459 ft, which makes it the world's highest transmission tower. Cost of the line fell just a little short of a million dollars.

Then there were the Newark-Alviso line, $216,000; the Manteca-Salinas line, $424,000; rebuilding of East



INTERIOR OF SUBSTATION L IN SAN FRANCISCO SHOWS COMPACT AND CONVENIENT ARRANGEMENT OF EQUIPMENT

In North Bay division $230,000 was spent on rehabilitating substations and providing facilities for additional service, work of that nature being done in San Rafael, Healdsburg, Talmage, Sonoma, Sebastopol, Alto and at Mare Island Navy Yard.

San Jose saw rapid progress made on the building of a new substation that will cost $584,000.

Manteca substation in San Joaquin division was reconstructed. Transformer capacity was doubled and switches installed for the new line to Salinas and the incoming Melones line. In that work $307,000 was expended.

Quick work was done in supplying current for the plant of the Calaveras Cement Company near San Andreas. Pacific Gas & Electric builders began the foundation for the substation on March 1; on May 7, less than 10 weeks later, it provided power for the cement plant.

Bay distribution lines, $115,000; Novato-Olema line, $125,000; re-routing of lines around Sacramento, $135,000; reconstruction of lines between Colgate and Smartville, no win progress, $126,000.

All that comprises only the larger jobs; there are hundreds of others of no small importance, every section sharing in the construction expenditures of the electrical department.

SMOKE ABATEMENT investigation at Salt Lake City is issued by the Bureau of Mines, Washington, D. C., as Bulletin No. 254. It describes the peculiarly difficult topographical and weather conditions which increase smoke troubles and the systematic methods employed to combat the evil. The production of smoke from plants in the industrial and business districts is reported as having been reduced 95 per cent within approximately 5 yr. Copies of the bulletin may be obtained free of charge.

Inland Steel Co. Completes New Power Plant

BOILER FIRED BY BLAST FURNACE KILNS AND AUXILIARY OIL BURNERS WHICH SUPPLY STEAM FOR TURBO-GENERATORS AND TURBO-BLOWER

MODERN trends of the steel industry are toward the utilization of blast furnace gas in an economical manner and the Inland Steel Co. of Inland Harbor, Ind., have just completed a new power and blowing engine embodying all the features of modern power plant development.

Electric current is supplied by three 12,500-kv.a., 2400-v., 3-stage, 25-cycle Westinghouse turbo-generators, designed to use steam of from 270 to 300 lb. per sq. in. at 200 deg. superheat. The generators have closed air cooling systems with spray type air washers and are

Turbines and condensers are supported on structural steel foundations carried on a reinforced concrete slab of such dimensions as to limit the load to approximately 1500 lb. per sq. ft. This concrete slab rests directly on the sand and no piling is used.

Condensers are arranged longitudinally under the turbines with duplicate motor-driven condensate pumps and duplicate two-stage air ejectors with inter and after coolers provided for each condenser. Condensate from the hotwell is pumped through these coolers in series, each condensate pump and each air ejector is large

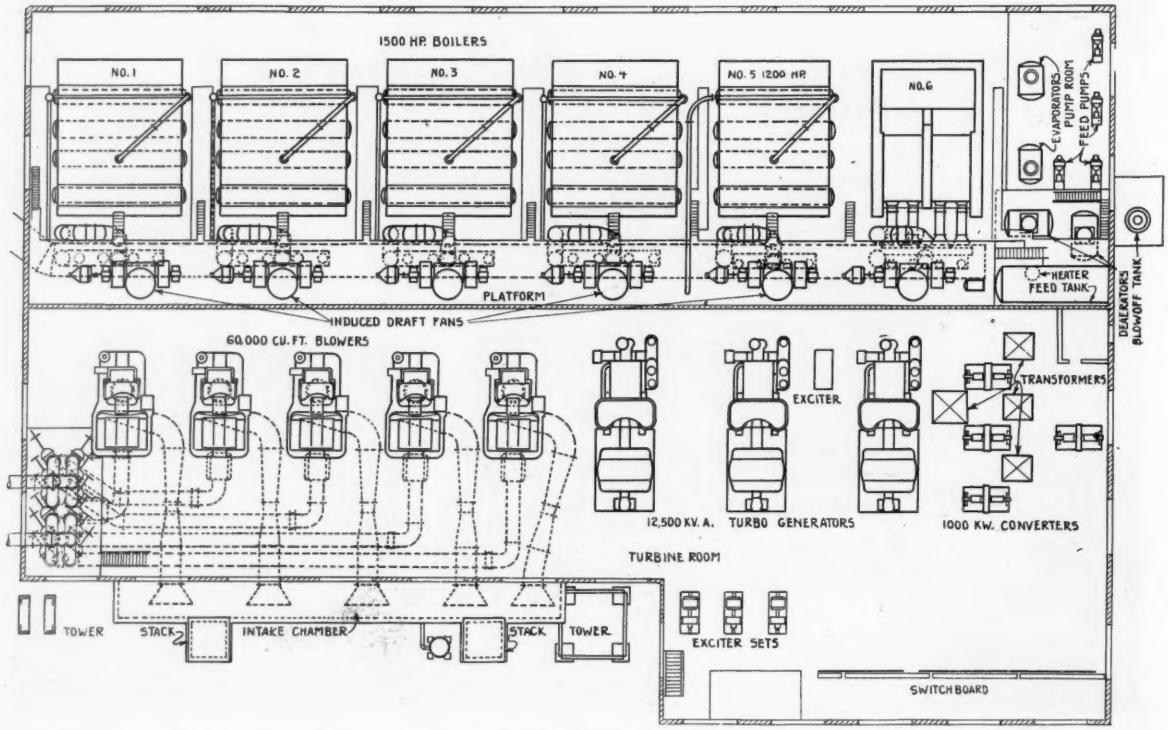


FIG. 1. PLAN OF THE POWER HOUSE SHOWING THE ARRANGEMENT OF ALL EQUIPMENT

connected by cables to the switch structure in the basement. Duplicate busses are provided and the switchboard is located on the floor immediately above the cell structure and behind the turbines.

Direct current is supplied by four 1000-kw., 250-v. rotary convertors, located on the turbine room floor and are supplied with current through individual transformers placed in the basement immediately below.

In addition to the electrical equipment, five Ingersoll-Rand blowers with a capacity of 60,000 cu. ft. of free air per min. against a pressure of 30 lb. per sq. in. supply air for the blast furnaces. At full capacity the turbines driving these blowers develop approximately 7000 hp. each. The air piping is so arranged that blowers can be used on different blast furnaces, ordinarily four blowers are used, the fifth one being used as a spare. Pressure and volume can be regulated by hand or by remote control from the control board.

enough to take care of the unit under normal conditions.

Two-pass condensers with a surface of 15,000 sq. ft. each are used with the turbines driving the electric generators. The turbo-blowers are served by units with a surface of 5300 sq. ft. each. These are also of the two-pass type but are arranged with divided water boxes. Condensing water is supplied from the pump house on the lake front by three motor-driven centrifugal pumps with a capacity of 2450 g.p.m. each against a total head of 30 ft. Provision has been made in the pump house for three additional pumps. Water flows through a 60-in. cast-iron pipeline a distance of about 1200 ft. to the power house and the individual condensers are supplied from this line. The amount of water passing into the condensers being regulated by gate valves, the quantity flowing depending upon the inlet temperature and the load being carried.

Water discharged from the condenser flows to a

trench with a sump at one end and a discharge into the sewer at the other. Three motor-driven centrifugal pumps with a total capacity of 2100 gal. per min. against a head of 120 ft. take their suction from this pump and supply service water to the plant. Water in excess of the demand of this pump flows over a discharge weir back to the lake.

As can be seen from the plans, Fig. 1, the boiler room is located parallel to the turbine room and steam is supplied by four 15,000-sq. ft. and two 12,000-sq. ft. Heine "V" type boilers with integral economizers. The economizer surface is equivalent to approximately 60 per cent of the boiler heating surface. Each boiler is provided with an individual fan located on a platform in front of the boilers and this discharges to a short steel stack immediately above. The fans are driven by direct current motors and regulated automatically to maintain a constant pressure in the combustion chamber independent of the variation in the amount of gas burned.

Four burners are used on each boiler, each with individual valves controlling the flow of gas. These valves are 16 in. and 20 in. respectively on the 12,000-sq. ft. and 15,000-sq. ft. boilers and are located in a gas box in front of the boilers. This box in turn connects with the 7 ft. 6 in. gas main through a water seal. The burner outlet valves are 24-in. and 30-in., respectively, on the large and small boilers. Gas boxes in front of the boilers are arranged so that they may be washed out and the accumulated sludge discharged to the trench in the basement of the boiler house. Because the blast furnace gas carries an increasing amount of dirt in the form of sludge and water, provision is made for washing the gas main and gas boxes without interfering with the operation of the boiler.

Make-up is furnished by Griscom-Russell three-stage evaporators with a capacity of about 10,000 lb. per hour. Lake water is first preheated in an open heater and the vapor from the raw water discharged into the main exhaust line and condensed together with the steam from the boiler feed pump turbines, in the deaerating heater, while the condensate is drained directly to the same heater. The deaerating heater reduces the oxygen content of the feed water to approximately 0.05 c.c. per liter.

Although the first unit has been in service for some time, the turbo-blower and last turbo-generator were not put into service until this year. Operating results have been satisfactory and in normal operation the power station is generating kilowatt-hours with less than 20,000 B.t.u. All gas is measured and ample metering provisions made to check the operation of all units.

During a week day, the electrical load varies from about 20,000 to 30,000 kw., being largely controlled by demand from the mill. Approximately one-third of the steam generated is used by the turbo-blower. The remainder goes to the turbo-generator which supplies the bulk of power used in the mills, although an older station with coal-fired boilers is maintained for stand-by service. Changes on the boilers have been practically negligible and the boilers run continuously for six months without shut-down. They are then taken off the line, inspected by the boiler inspectors of the insurance company and any necessary repairs made to the brick work. It is usual to have the boiler back on the line within three or four days of the time it was shut down. In normal service the boilers run between 160 and 200 per cent rating depending upon the load and the gas available. They can, however, be run as high as 200 per cent if necessary.

Oil burners are provided on four of the boilers to assist in steam generation when there is a gas shortage. It occasionally happens that there is a shortage of gas and at this time the oil burners are used to compensate.

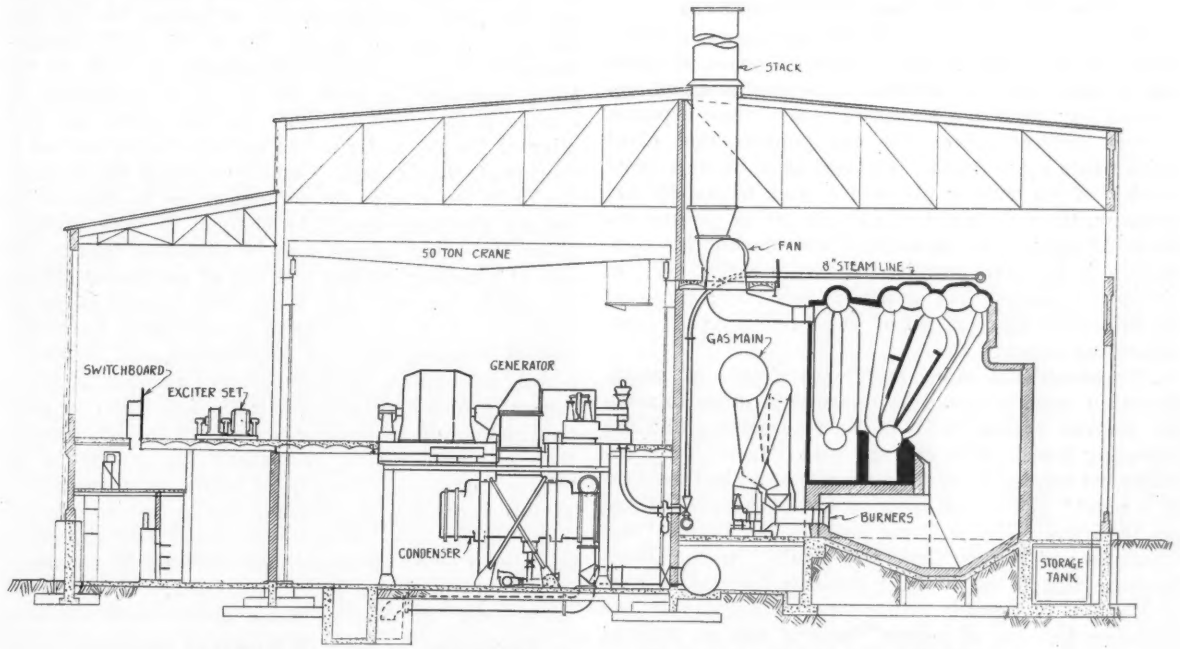


FIG. 2. TURBINES AND CONDENSERS ARE CARRIED ON REINFORCED CONCRETE SLABS

Manufacturing Expense of Ice Making Plants

Simple System of Accounting for Combination Ice-Making and Cold Storage Plants. By Fred Ophuls*

FOR THE PURPOSE of this analysis, "Manufacturing Expense" will be made up of the following: Salaries and wages of all labor employed in the power house, for the manufacture of ice and for placing it in the ice storage, fuel or power, ammonia, oil and waste, water and sundries. The expense included under these items will be called "Direct Expense." Furthermore, repair of machinery, both material and labor, repair of buildings, taxes, insurance, depreciation. The expense recorded under these last items will be called "Indirect Expense."

Cost Analysis Is Basis for Improvement

Minute analysis of manufacturing expense is interesting to the refrigerating engineer because it gives him an opportunity to determine the good and bad features of any plant and by comparison of these expenses between different plants, he can improve that plant which needs improvement. In these days, where a great number of ice making plants are often owned by one company, the comparison of manufacturing expense becomes of very great importance indeed and this comparison is no easy task because wage scales vary in different localities; fuel or power costs vary; and local conditions are different, all of which reflect on the manufacturing expense.

We should determine how many details of manufacturing expense should be recorded in order to make the analysis of real value to the management and the operating force. How can the item, "Labor," for example, be segregated to show the good and bad features of a plant? The usual division is very simple. There are the items, "Power House Salaries and Wages" and "Salaries and Wages, Tanks and Vaults," in the Direct Expense and in the Indirect Expense there is an item of "Labor Chargeable to Repairs." Included in the Building Repairs, of course, there is also an item of labor.

Labor Cost Analysis

What then can we learn from the labor expense in a plant? Taking the power house, for example, we have to have a chief engineer with his assistants and possibly oilers, and if the plant is fairly large and complicated, some handy men; and also if it be steam driven, firemen and coal passers. The question is whether or not such salaries and wages charged to power house without any segregation, will tell the whole story. It does not seem sufficient merely to know the total wages in the power house; a knowledge of how this labor employs its time is absolutely necessary. The only way that this can be found is to segregate the power house labor cost into two items: first, cost of supervision and operation of the machinery; and second, cost of upkeep. In this instance we mean by "Upkeep" all the labor, other than that necessary for actual repairs, which is necessary to keep the apparatus in good operating condition. Upkeep, for instance, would include such items as the cleaning of boilers and the packing of a pump or a piston rod. This segregation is valuable because it shows the management an expense which is incidental to its plant alone. All plants must have operating engineers and possibly oilers and other help, but some plants need more or less help for upkeep. This item no doubt varies with the type of machinery in a plant and also with its age. Therefore, if this item of upkeep becomes appreciable, it is necessary to find out whether or not improvements can be made to decrease its amount or eliminate it entirely.

Similar reasoning applies to the salaries and wages, tanks and vaults. This labor item should be divided into the labor actually needed to harvest the ice and the labor needed to handle the ice for daily storage. Furthermore, a separate item should be made of the labor necessary to store the ice in a permanent ice storage if the plant has one. At this point, the handling of the ice, as far as the manufacturing expense is concerned, should stop. Cost of removing the ice from the daily ice storage or permanent ice storage to the loading platform should be charged to sales expense. These two items should also be separated because the cost of handling ice into and out of permanent storage is considerably more than is apparent to most ice manufacturers. If, to these items, a proper charge for refrigeration required and for depreciation and upkeep is added, the expense of storing large amounts of ice is generally found to be considerable and often so great that increase in ice-making capacity of the plant rather than establishment of permanent ice storage is the proper procedure. There is, of course, an advantage in having stored ice, as sudden peaks in ice sales can be more readily met. If excessive peaks, that cannot be taken care of by an ample daily storage, do not occur, it is doubtful that a permanent storage would be advantageous. Storage ice is not always readily salable.

Accounting for labor on repairs to machinery is also difficult and not often as complete as it should be. In most plants repair labor consists only of machinists, helpers, blacksmiths and other labor that actually make the repairs. Strictly speaking, this is not correct because the repair crew is supervised by the chief engineer or his assistants, who often, particularly in off peak seasons, spend a great deal of their time on this work. The same is true of the item of upkeep mentioned above.

Cost Segregation Determines Renewal Conditions

It may appear at first glance that such minute segregations are unnecessary but the fact is that they are of great importance to the management. If such segregated costs are not available, how is it possible for the management to tell when the time has arrived to remodel the plant? When that time comes, these figures will be of the greatest help in giving the manager the opportunity to show the owner in dollars and cents exactly what he will save yearly by the expenditure of a certain expense for renewals and how soon the book value of the machinery and apparatus thus discarded can be written off. Because of the lack of such figures, renewals are often not made and plants are allowed to

*President, Ophuls & Hill, Inc., New York, N. Y. Abstract of a paper presented at the annual meeting of the American Society of Refrigerating Engineers, Dec., 1926.

become obsolete. All owners are loath to spend money for renewals unless they can see that a good business proposition is involved. Renewals of machinery and apparatus are warranted when the book value can be written off in from three to five years and the savings return 15 to 20 per cent on the new investment; possible increase in interest, taxes and depreciation of the new equipment being deducted from the saving in manufacturing expense.

Steam and Electric Plant Costs

In view of the difference in the wage scales in various localities, it is difficult to compare the labor item of plants unless either wages are standardized to a common wage scale or else the number of man-hours is specified. This likewise applies to the cases of fuel and power. The cost of fuel and of electric power varies in different parts of the United States. For this reason, it is necessary to standardize power cost when comparison of the manufacturing expense of a great number of plants is attempted. This is by no means a very easy matter because one must have a full knowledge of the cost and quality of the fuel fired by each of the plants in question and the efficiency with which it is used. When these factors are known, the fuel cost can be changed to an adopted standard. While it is perfectly easy to compare the fuel cost of various plants as long as they use boiler systems fired with coal, oil or natural gas, this question becomes more complicated when it is desired to compare a steam plant with an electrically driven plant. It is impossible to compare the electric power cost per ton of ice produced with the fuel cost per ton of ice produced because these two items are made up of entirely different factors. Since it is very desirable, however, to make a comparison of these two types of plants, particularly since there are a lot of companies that own both types, it is necessary to find some way by which a comparison of fuel and power cost can be made.

After giving this subject a great deal of thought, we finally came to the conclusion that the price one pays for electric current includes the cost of the fuel that was necessary to produce it, cost of labor, of sundries, the taxes, the depreciation and some profit. If, then, we find a means by which the electric power cost can be segregated into the corresponding items of manufacturing expense, a correct comparison of the electric and steam driven refrigerating plants can be made. Taking advantage of the information gathered, we decided, for the present, to divide the electric power cost into its items of manufacturing expense according to the following percentages:

Segregation of Electric Power Cost

		Per Cent
(a)	Salaries and wages, power house	23
(b)	Fuel	30
(c)	Oil and waste	2
(d)	Sundries	2
(e)	Machine repair, labor	6
	Material	6
(f)	Taxes	2
(g)	Insurance	2
(h)	Depreciation	27
		100

This segregation of the electric power cost must vary somewhat when electric power is purchased from various public service companies. In all first attempts, it is better to start with something, however incomplete the data may be. When it is found that such a segregation of electric power cost is valuable for this analysis, the power companies may help to prepare schedules themselves for this purpose.

At first glance the percentage allotted to fuel seems to be low and needs some checking. This can readily be done. Large electric power companies, burning coal of 14,500 B.t.u. per lb., can deliver high tension current to an ice plant on a consumption of 2 lb. of coal per kw-hr. The average electrically driven ice plant produces one ton of ice for every 50 kw-hr. consumed. This means that in the power house of the public service company 100 lb. of coal are burned per ton of ice produced in the ice plant. For coal costing $4 per t., this represents a cost of 400 ÷ 20 or 20 cents for fuel per ton of ice manufactured and 20 t. of ice manufactured per ton of coal fired. These are conservative figures.

TABLE I. ANALYSIS OF MANUFACTURING EXPENSE OF STEAM-DRIVEN PLANTS PER TON OF ICE MADE DURING MONTH

Description of Item	Plant 1			Plant 2			Plant 3		
	1	2	3	1	2	3	1	2	3
Direct Expenses									
Sal. & Wages Powr House	0.541	0.541	0.438	0.423	0.423	0.399	0.418	0.418	0.384
Sal. & Wages Tanks & Vaults	0.107	0.107	0.215	0.278	0.278	0.238	0.153	0.153	0.153
Fuel	0.498	0.450	0.380	0.432	0.394	0.373	0.715	0.521	0.263
Ammonia	0.043	0.043	0.020	0.077	0.077	0.020	0.044	0.044	0.020
Oil & Waste	0.024	0.024	0.024	0.029	0.029	0.029	0.038	0.038	0.038
Water	0.052	0.052	0.052	0.007	0.007	0.007	0.031	0.031	0.031
Sundry	0.002	0.002	0.002	0.033	0.033	0.033	0.028	0.028	0.028
Total Direct Expense	1.267	1.219	1.131	1.279	1.241	1.099	1.447	1.253	0.917
Indirect Expense									
Mach. Repair Material	0.031	0.031	0.031	0.019	0.019	0.019	0.034	0.034	0.034
Mach. Repair Labor	0.095	0.095	0.095	0.011	0.011	0.011	0.105	0.105	0.105
Bldg. Repair	0.065	0.065	0.065	--	--	--	0.002	0.002	0.002
Taxes	0.096	0.096	0.096	0.118	0.118	0.118	0.116	0.116	0.116
Insurance	0.046	0.046	0.046	0.099	0.099	0.099	0.029	0.029	0.029
Depreciation	0.672	0.672	0.672	0.460	0.460	0.460	0.519	0.519	0.519
Total Indirect Expense	1.005	1.005	1.005	0.707	0.707	0.707	0.805	0.805	0.805
Total Mfg. Exp.	2.272	2.224	2.136	1.986	1.984	1.806	2.252	2.089	1.722
Tons Ice Made	2304			3196			4768		

Column 1 represents actual cash outlay without adjustment

Column 2 represents cost adjusted for fuel item only

Column 3 represents actual costs as author thinks they should be, based upon analysis of other figures in table.

Electric power cost largely enters in the item of depreciation. A very large investment per kw. output is necessary, not so much for the generating plant as for the distribution system, which is the part of the property most subject to depreciation and obsolescence. To see clearly the effect that distribution of electric power costs have, according to this method, on the various items of manufacturing expense of electrically operated ice plants, as compared to the respective items for steam driven plants, Tables I and II which show the actual manufacturing costs for a summer month of three steam driven and three electrically driven ice plants, are submitted.

In the foregoing analysis of manufacturing expense, no attempt has been made to segregate the labor items

in the manner described above, since the costs came to us in this form.

The figures in column 3 are difficult to prepare as a most complete knowledge of the machinery equipment of the plant and of all local conditions that may in any way affect these figures is required. A comparison of the corresponding figures in columns 2 and 3 gives an idea of the efficiency with which the plant is being operated by the crew. This comparison offers the management the opportunity to check up the operating departments and keep them alert at all times.

TABLE II. ANALYSIS OF MANUFACTURING EXPENSE OF ELECTRICALLY-DRIVEN PLANTS PER TON OF ICE MADE DURING MONTH

Description of Item	Plant 4			Plant 5			Plant 6		
	1	2	3	1	2	3	1	2	3
Direct Expense									
Sal. & Wages Power House	0.141	0.298	0.280	0.166	0.388	0.363	0.150	0.327	0.252
Sal. & Wages Tanks & Vaults	0.169	0.169	0.159	0.267	0.267	0.166	0.164	0.164	0.124
Fuel	0.662	0.142	0.129	0.966	0.219	0.176	0.750	0.174	0.142
Ammonia	--	--	0.020	0.074	0.074	0.020	0.071	0.071	0.020
Oil & Waste	--	0.013	0.012	--	0.019	0.014	--	0.015	0.013
Water	0.058	0.058	0.058	0.080	0.080	0.080	--	--	--
Sundry	0.042	0.055	0.054	0.163	0.182	0.177	0.017	0.032	0.030
Total Direct Expense	1.072	0.735	0.712	1.716	1.229	0.996	1.152	0.783	0.581
Indirect Expense									
Mach. Repair Material	--	0.041	0.037	0.024	0.082	0.067	0.005	0.051	0.043
Mach. Repair Labor	--	0.041	0.037	0.022	0.080	0.065	0.013	0.059	0.051
Bldg. Repair	--	--	--	--	--	--	0.027	0.027	0.027
Taxes	0.079	0.092	0.091	0.007	0.026	0.021	0.040	0.055	0.053
Insurance	0.029	0.042	0.041	0.007	0.026	0.021	0.008	0.023	0.021
Depreciation	0.468	0.652	0.633	0.406	0.667	0.608	0.397	0.605	0.567
Total Indirect Expense	0.576	0.868	0.839	0.466	0.881	0.782	0.490	0.820	0.762
Total Mfg. Exp.	1.648	1.603	1.551	2.182	2.111	1.778	1.642	1.603	1.343
Tons Ice Made	1415			1474			4007		

Column 1 represents actual cash outlay without adjustment

Column 2 represents costs that have been segregated into component parts and allocated

Column 3 represents actual costs as author thinks they should be, based upon analysis of other figures in table

After the manager receives these reports and finds, for example, that the fuel consumption should be smaller than it actually was, he can immediately consult with the chief engineer and by joint co-operation readily obtain better results.

In a like manner other details may be analyzed and bases for improvement in efficiency obtained.

Keep Off the Grass

APPROACH OF SPRING is accompanied by signs which greet us with the above words. What is really meant is not "Keep off the grass," but keep off the bare spots—the paths that have been worn in the lawn by persons who have followed one another in the same beaten path for no other reason perhaps than that it is a beaten path.

Watch the bare spots in your chosen line but keep off of them. There is a much more fertile field adjacent to beaten paths. Why not give your own ingenuity unconfined and unrestricted opportunities for expression?

DON'T EXPECT your water softener to operate efficiently if it is not cleaned out periodically.

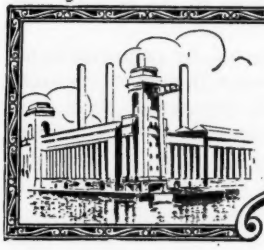
Electric Ice Plant Includes Apple Storage

IN THE CENTER of the apple orchard country of Virginia, the Kentucky Utilities Co. recently put a new 35-t. raw water ice plant in service. The plant, located at Norton, Va., is a fireproof structure of brick, steel and concrete, with a cement tile roof, steel doors and steel sashes. Two large apple storage rooms refrigerated by the ice machines are provided. In addition, a brine line is installed to give standby refrigeration service to an adjoining plant of the Norton Packing Co.

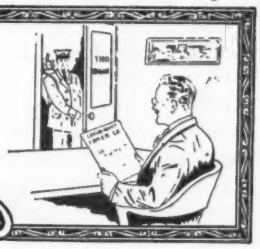
Two compressors, one an 11 by 13-in. and the other an 8 by 8-in., are provided. Although the 8 by 8-in. machine is not necessary for the 35-t. capacity tank, it is used in the off season for cooling the storage rooms and making small quantities of ice. Two shell and tube condensers are used in connection with a dual water system. When available, water is pumped from a deep well by air lift and circulated over the condenser by a centrifugal pump. When the well supply fails water is taken from the city mains. From the condenser pit the water is pumped through spray nozzles in a cooling pond on the roof of the plant. For ice making, water from the city mains is treated and filtered before using.

A WELL-LIGHTED BUILDING OF FIREPROOF CONSTRUCTION HAS BEEN PROVIDED

RECENTLY A REPORT on the water resources of California was submitted to the 1927 Legislature by Paul Bailey, State Engineer. A co-ordinated plan contained in the report recommends storage of flood waters for conservation purposes; transportation of surplus waters of the Sacramento to drainage basin to the deficient areas in the San Joaquin valley; an adequate summer flow in the Sacramento River for navigation and salt water control; the resumption of hydraulic mining in the Sierra Nevada mountains; the control of floods by reservoirs; expansion of irrigation along the lower Colorado River in Southeastern California, and the diversion of water from that river to the Pacific Coast for municipal purposes.



LETTERS DIRECT FROM THE PLANT



Retubing a Surface Condenser

AFTER YEARS of continuous operation it became necessary to renew the tubes and tube sheet of a 15,000-sq. ft. surface condenser. Many difficulties were encountered in making this renewal but by following the course described below, the job was accomplished in comparatively short time.

After removing the condenser heads and retaining screws from the tube sheet, thin wedges were inserted between the tube sheet and condenser to force the sheet

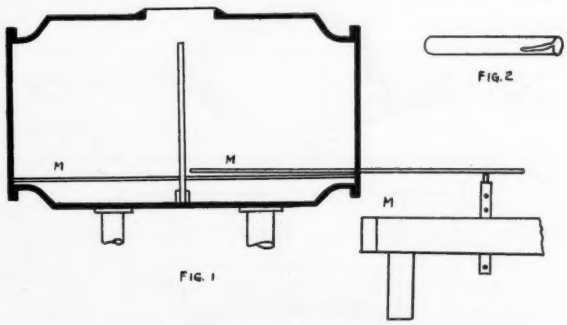


FIG. 1. ILLUSTRATING HOW THE 18-FT. TUBES WERE SO GUIDED AS TO PREVENT CROSSING THEM

FIG. 2. PACKING TOOL SO ARRANGED AS TO WIND THE PACKING TWINE AROUND THE TUBE WHILE IT IS BEING PACKED

off of the tubes, this being thought to be the quickest method as the tubes were to be junked. But the wedges merely caused the tube sheet to spring when the force was applied, returning to its original shape when the force was removed. A one-ton chain hoist was then fastened to the center of the sheet but this also proved to be unsatisfactory, the friction of the packing on the 2100 tubes and also their combined weight seemed to be too much so this method was abandoned.

Recourse was then made to a pneumatic hammer. A tool, having a diameter at its end sufficient to permit it to protrude a short distance inside the end of a tube, and provided with a shoulder which was of the same outside diameter as the outside diameter of the tube, was used in the hammer and the tubes driven, one after another, out of the tube sheet, permitting the easy removal of the sheet.

In retubing the condenser, after setting up the new tube sheet, three men, located as indicated at M in Fig. 1, were required to insert the new tubes. One man inserted the tubes through the holes in the outer sheet and slid them along to a second man who guided them through the center sheet or support. A third man guided them into the rear sheet.

Several men then placed the ends of the packing in the stuffing boxes. The packing consisted of a corset lacing twine and was inserted clockwise around the tubes. The packing tool used is shown in Fig. 2. It consisted of a thin brass tube about 12 in. long with a curved slot wide enough to guide the packing and wind it around the tube. The loose end of the packing, which protrudes from each of the stuffing boxes, is put through the packing tool and a light wooden mallet used to tamp the packing while the tool is twisted around by hand.

After packing was completed, the ferrules were tightly screwed back in place. The condenser was then tested by filling it with water. No leaks, however, were found so it was closed and put into service.

New Bedford, Mass. R. G. SPOONER.

Why Central Stations Get In

SOME FEW YEARS ago I secured a position as engineer in charge of a local plant under the supervision of the chief, who also filled the position of master mechanic. The first week convinced me that the plant was about ready to open the front door to some central power station and the rear to the junkman.

The boilers were hand-fired, water-tube boilers. They were set low, close to the grate. I am sure there was not more than 18 in. between the rear of the firebox and the lower tubes; however, as the morning fireman always had the fire up to the tubes in the rear, this probably saved some waste of fuel.

The engine room equipment consisted of a 20 and 30 and 40 by 60-in. triple expansion Corliss engine, turning 67 r.p.m., and a 16 and 32 by 48-in. cross-compound engine of the vertical type that turned 112 r.p.m. The Corliss engine exhausted into a jet condenser and the cross-compound engine into a barometric condenser.

A survey of the plant brought out the need of immediate attention, and, as the owner started to howl, I was delegated to get busy. I overhauled the Corliss engine, putting new gaskets on all the bonnets. The dashpots were sluggish, so I dismantled them, cleaned them, reassembled them and adjusted them. The piston rod was worn so badly that at every stroke of the engine considerable steam was lost. As the high and intermediate cylinders were in tandem, we had to take out the cradle before we could remove the rod. We had the rod turned down and a new metallic packing put in. The pistons were centered, crossheads leveled and a new crankpin put in on the high-pressure side.

Next, the jet condenser and air pump were overhauled. A new piston rod and a valve rod was put in the air pump. Upon starting we pulled 26 in. vacuum with the discharge at 110 deg., and the engine was running so quiet you would not realize you were in the same engine room.

My attention was next directed to the cross-compound engine. Vacuum on the gage showed 17 in. Indicator cards showed loose connections and that all the work was being done by one end of the high-pressure cylinder. A new set of metallic packing on the low pressure rod and a new gasket in the disk of the atmospheric valve brought the vacuum up to 26 in. Taking off the valve plate on the head-end of the high-pressure cylinder disclosed a broken valve-stem on the main steam valve. A new rod was put in. I then keyed up and adjusted all the loose boxes and valve-gears. When we started up this engine, I took indicator cards and they showed that the valves were set very well.

I next overhauled all the pumps: There were nine of them. I put in new piston rods and valve rods. All in all, I did all I could to bring the plant up to as high a peak as was possible. Closer watch was kept on the firemen and they were shown how to fire in the right manner. If anything needed repairing, it was repaired at once.

At the end of my first year, I compared my total horsepower-hours with those of the previous year. I found that I had run more horsepower-hours and had burned far less coal than was burned during the preceding year. Accurate figuring showed a saving of a ton and a half of coal, or about $10 a day.

At or near the end of the next year, during which I had kept the plant up to the high level to which I had brought it, and my cost per kw-hr. was found to be only 2.8 cents, I decided that I was justified in asking for an increase in salary. I made my request, but my employers could not see their way clear to give me an increase of $5 a week.

I therefore secured another position and left the plant where I had put in many a busy hour. The superintendent wished me lots of luck and thanked me for the good work I had done while in the plant. So I walked out not so rich in worldly goods, but richer in the experience I had acquired.

I don't regret the hard work nor the long hours, but I often wonder if owners of plants, run such as this, ever realize how they are aiding in the creation of dividends to owners of central station stock.

Boston, Mass. RONALD MACQUARRIE.

Bursting Oil Tank Causes Fatal Accident

AT ONE OF THE substations of a power company a fatal accident caused by a method of operating which should be guarded against recently occurred.

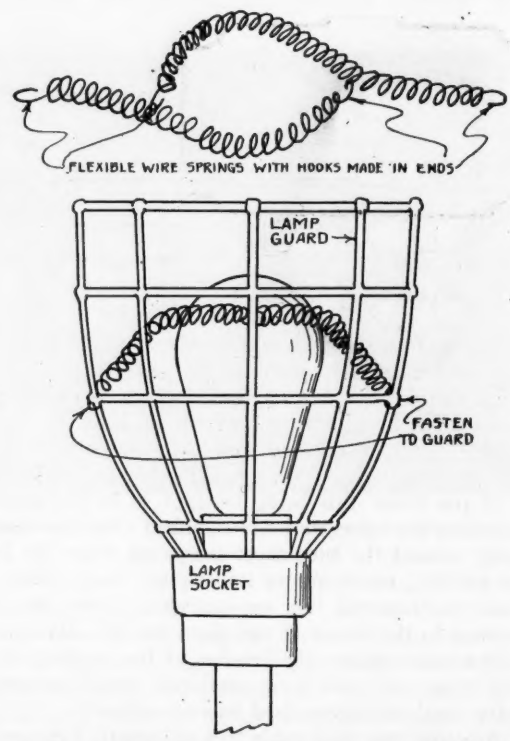
Oil had been drained out of the transformer and it was being refilled from a 50 gal. iron tank using compressed air to elevate the oil into the transformer shell. The air hose was connected to the ¾-in. hole of the tank and pressure was taken from an 80-lb. supply regulated by a globe valve. The operator was standing on a ladder above the oil tank observing the oil level in the transformer when, for some unknown cause, the oil slowed down; the air pressure built up in the tank caused it to burst; one piece hitting the man, cutting his lower jaw clear off. The hose connection broke and hit him in the face breaking his upper jaw and cutting his nose off. He fell backward on the concrete floor and fractured his skull. He was taken to the hospital and died five hours later.

This practice of transferring oil by compressed air is widely used. It should be done with care as the tanks are usually unsafe above 10 lb. pressure. Since only few pounds of pressure will elevate liquids to a reasonable height without using a pump, one has to be careful of the pressure possible from the supply source. If much transferring has to be done by compressed air a reducing valve should be connected to the air hose. The use of an electrically driven rotary pump is believed to be the most reliable method.

Clarkdale, Ariz. CHAS. LABBE.

Preventing Electric Lamp Bulbs from Loosening

PORTABLE LAMPS, used around machinery, or fixed lamps subject to the vibration of machinery, are often loosened and unscrew from the lamp socket. It is more



SHOWING HOW TO PREVENT VIBRATION FROM CAUSING LAMP BULBS TO UNSCREW

or less dangerous to have a light go off temporarily, as the mechanic attending a machine is apt to be caught by some moving part.

To prevent the lamp from backing out of the socket, the method shown in the attached sketch was devised. Two small springs, so connected that their inner ends encircled the bulb and their outer ends attach directly to the lamp guard, furnish a flexible pressure. This pressure is great enough to prevent vibration being conveyed to the bulb, but flexible enough to permit the removal and replacement of the bulb when required.

Washington, D. C. G. A. LUERS.

Efficiency Topics

AN ENGINEER who, I believe, knows more about steam flow meters than anyone else, said this not long ago: "It may prove highly profitable to buy a steam flow meter in order to learn that it doesn't pay to use a steam flow meter. For example, if you are using considerable steam in a department and are not sure about the profitableness of the steam, I would install a steam flow meter, find out, and if I learned positively that electrical operation would be better I would throw out all of the steam equipment, including the steam flow meter itself, and install electrical apparatus." Thus the steam flow meter would prove to be a boomerang (by eliminating itself). But, isn't that the proper way? That is what this writer calls "good business."

The writer is informed that in the power plant of a prominent industry in Little Falls, N. Y., they had their fireman, engineer, general manager and insurance inspector report on their boiler. Unanimously they reported them "clean." That is, they were considered "free from scale." However, they were prevailed upon by a tube cleaner salesman to try out a tube cleaner and were surprised to find, after using the cleaner, that a "clean" boiler contained 400 lb. of scale at the very time when it was pronounced clean. It pays to keep boilers scrupulously clean.

I have before me an advertisement containing this heading "The Way to Save Coal Is to Burn All the Coal."

While this may sound like good reasoning, it nevertheless is misleading and incorrect. It is possible to burn every atom of the coal and yet waste 100 per cent of it. If, for example, a boiler is so thickly coated with scale on the inside and covered with such a thick coating of soot on the outside that heat will not penetrate, you can burn 100 per cent of your coal and waste every bit of it.

Furthermore, if the steam lines are not properly insulated, if there are a great many leaks, if too much air is used in combustion, if the boiler setting leaks, etc., it is evident that burning all the coal is not going to help much.

The point I wish to drive home is that all factors must be considered, not only the single factor of burning all of the coal.

Newark, N. J. W. F. SCHAPHORST.

Reducing Bearing Noise

THE USE OF a phosphor bronze shim behind the wedge of the connecting rod crank bearing of a high speed direct-connected engine generator set, has saved the writer considerable annoyance. Before the use of the shim, it was necessary to take up the wear twice a week. If allowed to run all week, the bearing knock became very noticeable.

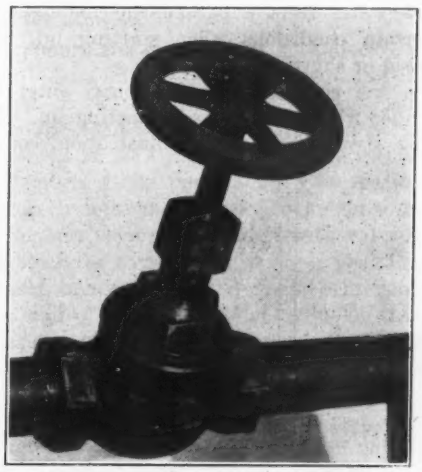
As the "take-up" was about one-half used up, the use of a bronze shim in front of the wedge was decided upon. The shim was cut to fit between the wedge and the box. Then, using the ball peen of a machinist's hammer, the shim was concaved its entire length. As soon as this shim was applied, a great difference in the behavior of the bearing was noticed. It is now possible to run for two weeks without any noticeable noise and, due to the elimination of most of the pounding, the amount of wear to take up is small. I believe the spring due to the concavity is responsible for the relief.

Moline, Ill. ROBERT ALTHAUS.

Rubber Grips for Valve Handles

HANDLES OF STEAM VALVES are always warm and frequently can not be handled without gloves, but gloves are not always a part of one's instant and immediate equipment.

By stretching a piece of an old inner tube of an automobile tire over the handle of such a valve it may be manipulated at all times without gloved hands.



RUBBER TIRED HANDLE MAKES STEAM VALVE MANIPULATION SURE AND BEARABLE WITHOUT GLOVED HANDS

After applying the rubber to the hot handle, it soon sets snugly on the iron and besides reducing the heat, makes the grip more sure to the grasp.

Missouri Valley, Ia. FRANK W. BENTLEY, JR.

Receiver Pressure for Compound Engines

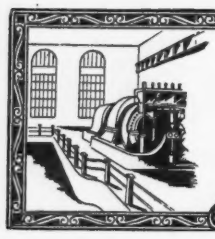
IN RECENT issues of Power Plant Engineering are several rules for finding the proper receiver pressures for compound engines. Some years ago a prominent engine company sent out the following rules to enable their erecting engineers to set the valves properly:

For non-condensing engines the rule is: Divide the steam pressure as shown in pounds by the indicator, by the ratio of the cylinders plus one. The quotient is the proper receiver pressure.

For condensing engines: Add to the steam pressure in pounds as shown by the indicator, the vacuum pressure in pounds as shown by the indicator. Divide the sum thus obtained by the ratio of the cylinders plus one and from the quotient subtract the vacuum pressure in pounds. The result will be the proper receiver pressure.

Portsmouth, N. H. H. G. MCKENNEY.

NO MAN can be happy unless he is on good terms with his stomach.



QUESTIONS AND ANSWERS

Comment on Water Backing Up Into Engine

REFERRING TO the question by C. L. P. as published on page 159 of the January 15 issue, an engine cannot draw back water from a barometric condenser except under certain conditions when starting up, running without load or shutting down.

Let us first consider how water may enter the engine cylinder while the engine is starting up. The exhaust pipe, shown at A in the illustration, connecting

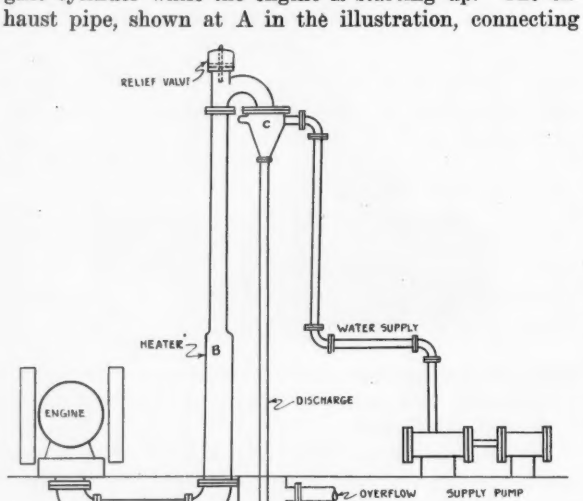


DIAGRAM OF ENGINE AND CONDENSING EQUIPMENT

the engine with the condenser, drops below the engine room floor and is likely to become full of water. To remove this water, we have an open drain to use before starting and a trap to remove condensation while running. If the water is not drained from this exhaust pipe before starting, the piston in the cylinder, acting as a dry air pump, will cause water to be drawn into the cylinder when the exhaust valve opens and after the exhaust valve closes, damage will result from the entrapped water in the cylinder unless relief valves of ample capacity are provided.

If the engine runs without load, the blocking off of the cone at C will cause water to overflow into the exhaust line and enter the cylinder. If the overflow pipe at D becomes blocked, water cannot drain from the hot well and, therefore, will back up into the exhaust line. The piston then, acting as a dry air pump, will create a better vacuum in the cylinder than exists, at the time, in the condenser, causing water to enter the engine cylinder and thus causing damage.

This condition will also apply when the hot well discharge pipe is too small and the amount of water discharged from the hot well is less than the amount entering it. In this case, water will be built up in the tail pipe. Also, if the discharge pipe becomes uncovered at F through leakage of the hot well at E, the water will be drawn into the engine cylinder in the form of a spray. Leakage of tubes in the heater B, which is assumed to be a closed heater, would also cause water to enter the cylinder.

In shutting down an engine, water may enter the cylinder in the manner last described.

Lawrence, Mass. ALVIN B. KANE.

IN ANSWER to C. L. P.'s question on page 159 of the January 15 issue, the following information, which was gained through a few years' experience with a tandem-compound high speed engine and a cross-compound engine, both of which exhausted into a barometric condenser, may throw some light on the problem.

In both cases, relief valves saved the cylinder heads from destruction. On investigation in each case, I found that the trap draining the horizontal length of exhaust pipe had become inoperative.

Running an engine with a vacuum in the receiver and a long horizontal length of exhaust pipe, without having a good trap connected to it, is as bad as running an engine without a governor.

Boston, Mass. RONALD MACQUARRIE.

Examination Question Contest

SUCH INTEREST was displayed and so many submitted answers to the set of examiner's questions printed in the October issue that it was decided to award three instead of just one prize as stated at the time. The spirit shown by the contestants was gratifying to the editors and it is believed that all who took part, whether or not they received an award, benefited by so doing.

After careful consideration, the contest committee picked the following as the winners.

1st—Jas. T. McCahey, Palmer, Mass.

2nd—John S. Fry, Nanticoke, Pa.

3rd—Stephen H. Velie, Queens Village, L. I.

Following are what are considered best answers, selected from those submitted by the winners:

1. If, in starting a small engine, it turned over two or three times and stopped, what would be the cause?

A. The exhaust valve is probably closed, exerting a back-pressure on the engine. If this is not the cause, I would open all the drains and blow all of the oil out of the cylinders and steam line until I had dry steam, then, if the engine stopped after two or three revolutions, I would look after the bearings to see if they were in operating condition. If so, I would see if the eccentric slipped and check up the valve setting.

2. How is a vacuum created? What is it? How is it used?

A. (a) Vacuum is obtained by pumping out or forcing all solids, liquids and gases from any confined space. This would constitute a perfect vacuum, which is impossible in practice.

(b) A perfect vacuum would be found in a space devoid of all matter. This would be equivalent to reducing atmospheric pressure to zero.

(c) Vacuum is used in the power plant field to reduce the exhaust pressure below that of the atmosphere, thus reducing the steam consumption for a given amount of horsepower.

3. How would you find the clearance of an engine? This question should have indicated which clearance was meant. It is necessary to know the clearance volume in order to make a proper analysis of an indicator diagram of an engine.

A. To find the mechanical clearance: If striking points are on the crosshead guide it is only necessary to measure the distance between such a point and the corresponding dead center position of the crosshead in order to obtain the mechanical clearance at that end. If the striking points are not on the guide the corresponding points may be obtained by disconnecting the connecting rod and moving the piston until it touches the head. Usually plugged holes are at each end of the cylinder in which case on removal of the plugs, direct inspection of the clearance is possible. Or, a piece of soft metal, such as lead, may be placed between the cylinder and piston heads and crushed when the piston is moved to the dead center at that end, the thickness of the lead then represents the clearance.

Clearance volume may best be obtained by placing the piston at dead center and packing it to prevent leakage, then filling the clearance space with a known weight of water. The cu. ft. occupied by this water can then be found by dividing the weight of water by 62.5 which is the weight of 1 cu. ft. of water.

4. Tell how you would start an engine if it had been shut down for 6 mo.

A. I would first examine the engine thoroughly to see whether all parts were in working order, then clean all bearings and wearing surfaces with kerosene, filling lubricators and grease cups with clean material and lubricating all surfaces. I would then crank the engine over by hand to assure myself that all parts were working freely. I would then crack the throttle valve slightly and allow the cylinders to warm up thoroughly. After the cylinders are warmed up, I would start the engine slowly and make sure everything was working properly before bringing it up to speed. After this I would close the drip valves, making sure, of course, that the cylinders were free from water.

5. What is the horsepower of an engine with 12-in. cylinder, 4 ft. stroke at 100 r.p.m. and 60 lb. mean effective pressure?

A. I.hp. = P l a n ÷ 33,000

where P = mean effective pressure in lb. per sq. in.
l = length of stroke in ft.
a = area of piston in sq. in.
= 12 × 0.7854 = 113.09.
n = number of strokes per min.
= 100 × 2 = 200.

$$\text{Then I.h.p.} = \frac{60 \times 4 \times 113.09 \times 200}{33{,}000} = 164.5.$$

6. How would you set a piston valve properly? How would you know that it was properly set?

A. (a) First find the dead centers by tramming two points on the flywheel rim corresponding with the positions when a point on the guide corresponds to a point on the crosshead when it is near the dead center so that when the flywheel turns over in one direction these two points will correspond just before and just after the dead center is reached. The two lines on the flywheel are then bisected, the middle point, when trammed from the same reference point from which the original tramming was done, will then represent the dead center position.

Now remove the covers from both ends of the valve chamber. Make an accurate template out of zinc of the valve and mark it "head end" and "crank end." Make another template of the valve seat, being sure to make one end of the template flush with the face of the valve chamber. The ports should be marked "head end" and "crank end" and should show both port edges. Replace valve and connect with valve gear.

Now block the governor to its outer position or minimum travel, turn engine on crank end center, next measure from end of valve to face of cylinder, transferring this measurement to the templates; this will show the amount of lead with the templates in this position. The governor blocking should be changed to a point corresponding to the cutoff for rated load. This point can be determined by measuring off the part of stroke at which the cutoff is to take place and marking it on the guide. The engine should then be turned over until the crosshead mark and guide mark coincide; the governor should be blocked so that the valve is line and line at the steam edge. This position may be found by taking the measurements from the template.

Turning the engine over to crank end center will show that cutoff does not occur at the same point of the stroke as at the head end due to the irregularity of the connecting rod. This will be seen by the marks on the crosshead and guide falling short of one another. Adjustment can be made by moving the valve endwise, which will increase the difference between the leads of the two ends of the cylinder. Greatest port opening for any cutoff can be determined by blocking the governor for that cutoff. The engine should now be turned over until the valve begins to change direction; this will give the maximum port opening for that particular cutoff.

The point of cutoff or point of admission can be obtained by placing the template of the valve on the template of the seat in such a position that the steam edge of the valve coincides with the steam edge of the port. A measurement is then taken from the edge of the template at the cylinder face end to the end of the valve and transferred to the valve in the chamber. By blocking the governor in a position corresponding to the measurement just taken, the point of cutoff or admission may be determined. All other events can be determined in this way.

(b) An indicator diagram will best show whether or not the valves were properly set.

(To be continued)

EDITORIAL COMMENT

Home-Made Articles Are Inferior to Manufactured

Many fine ideas have been developed into useful and economical devices by engineers in various power plants. It is not uncommon for those who are responsible for the idea to have it patented. This, of course, is the beginning of many of our present day devices. It is, however, only the beginning, for during the process of developing these devices into manufactured equipment, many improvements and changes have been made which are never foreseen by the inventor.

When a manufacturer takes over a patented article with the intention of putting it on the market, every detail of the manufacturing process is studied with extreme care, a survey is made of the available market, it is given severe operating tests, all noticeable weak points are perfected as far as the manufacturer's experts find it possible. Special machinery is designed and built to manufacture the device and men are trained in their special manufacturing duties. Thus, in the hands of the manufacturer, articles ranging in scope from bolts to turbo-generators, have reached a high degree of perfection the like of which no individual man could reasonably expect to duplicate.

Not infrequently, men with mechanical genius find a need for a device which they can make themselves and rather than put a requisition through the proper authorities they proceed with the tools and materials at hand to construct a home-made substitute for something which could be purchased almost as cheaply as the material used in the home-made device and give far better results. Water level regulators, temperature regulators for water, automatic control of room temperature, damper regulators, steam pressure regulators, metallic packing and boiler compounds are among the common home-made experiments.

Other than experience and a certain amount of knowledge, there is little to be gained by making home-made devices when something to serve the same purpose is already available on the market. This, of course, does not always apply in the case of equipment that is in the pioneering stage, as the user may find that with slight modification the equipment may have a new application. In an emergency, an engineer is always justified in clearing up a trouble as quickly and cheaply as possible and this may require home-made equipment, but for an engineer to make every kind of a device which he thinks would be convenient about the plant, is decidedly impractical. When the demand has reached the point where manufacturing is carried on profitably, it is extremely seldom that the home-made substitute is justified.

Visualizing Costs and Earnings

Recently a clever calendar was devised by Charles S. Chapman and published by the Committee on Public Relations of the eastern railroads, in which the twelve months appeared on a single sheet and over the squares of Jan., Feb., Mar., Apr. and May was written in heavy blue pencil the word "Wages." Over June was "Fuel"; over July, Aug. and a portion of Sept., the words "Materials and Supplies"; over nearly all of Oct. and Nov. were the words "Taxes and Interest"; nineteen days of Dec. showed for "Dividends" and only six days of Dec. for "Reserve Fund."

In this way were clearly shown and readily grasped the facts of the disposition of the earnings, in a way that no amount of argument and figures could accomplish. It was a complete refutation of the idea that the railroads are milking the public, since only 19 days out of 365 of the year are available for producing dividends.

Such methods of graphical presentation of facts are always effective and might well be used by large employers in placing before their organizations the salient facts as to cost of operation of the business and the returns to capital and the management.

Science Continues to Add to Our Coal Knowledge

When the subject of low temperature carbonization of coal is under discussion, many engineers are prone to wonder whether or not the increased value of the products and by-products of the various processes will ever be sufficient to compensate for the thermal losses and increased cost of the processes themselves. We are interested to note, therefore, that Dr. Lander, in his recent discussion of developments in the science of coal utilization, raised this question, pointing out that it justified the exploration of every avenue that might lead to improvement in methods of coal utilization.

The real purpose behind Dr. Lander's paper, however, was to show how many of the problems in coal utilization, while at first they may be purely theoretical investigations by scientists, often lead to important engineering applications. This is true, of course, of all research work, as we have previously pointed out. But it is interesting to note how applications of science which appeared visionary only four or five years ago now appear commercially practicable.

This has been true in the field of low temperature carbonization of coal and has led to several successful commercial installations in this country. But these merely scratched the surface of the subject. The present research work being carried on seems to be opening up wider and wider fields.

Extraction by solvents as in the Parr process, destructive distillation, direct hydrogenation at high tem-

peratures and pressures as used by Bergius, the controlled oxidation process of Wheeler—all these are fundamentally problems of organic chemistry and are leading to a vastly increased knowledge of the structure of coal. In the burning of pulverized coal, investigation of the "cenosphere" has been particularly helpful.

All this investigation is concerned with problems the solution of which will affect profoundly the work of the designer and operator of any type of coal-burning furnace. It may even lead to different methods of preparing coal for market. In any event, it indicates that the next hundred years will see changes in the methods of burning coal at least as great as those of the past hundred years. Just which preliminary process or processes of carbonization or gasification will prove most suitable for commercial exploitation depends on many circumstances. The engineer who is looking ahead, however, will surely take an interest in them, as the information about coal gained in the course of their development will have a great effect on the power plant of the future.

Off Duty

In this hodgepodge world of conflicting interests and ideas, where primitive instincts so often prevail over the precepts of reason, where nothing is enduring, and all things are relative, there appears to exist one fundamental truth, the significance of which grows more apparent each day. This is, that the fundamental basis of all phenomena in the universe is electrical in nature. To one who has not followed, closely, the progress of science, this may seem a broad statement and one which the peceding reference to a hodgepodge world would not justify. Yet, if we examine the facts available today, no matter from which angle the problem is approached, we come, inevitably to this conclusion. Whether we start with chemistry, mechanics, biology or optics, as investigation progresses, there finally comes a time when it becomes necessary to find expression in electrical terms.

This is reassuring for two reasons: first, it sustains a hope that the riddle of the universe may some day be solved and, second, it provides a gage with which to measure the progress of civilization. Through the hundreds of centuries since man emerged from the primitive, knowingly or not, his aim has been the understanding of nature. At each step in his conquest of civilization he interpreted natural phenomena in accordance with the capabilities of his mental equipment. His primitive instincts often defeated his efforts and, until quite recently, his ideas about everything were wrong, but the urge was always there.

When active interest in the sciences began, there seemed to be certain obvious lines of demarcation separating different branches of investigation. That branch dealing with the composition, transformation and reaction of substances, became the science of chemistry; that having to do with the laws of motion and matter was called mechanics. Similarly, that branch pertaining to the study of living things was called biology. The study of the properties of light and vision developed into the science of optics. Each of these branches of science was complete in itself and while it was realized early that the boundary lines between them were not as definite as first suspected, each was based on its own fundamental units. Chemistry was explained in terms of molecules and atoms, optics first, upon the theory of corpuscles, later in terms of ether waves, biology dealt with amoeba and protoplasm, mechanics was concerned with unit weights and motion. Furthermore, matter and energy, associated with all phenomena were regarded as absolute entities, indestructible and unconvertible.

Then came the discovery of the electron and with it the broad conception of a fundamental unit of matter. At first, the electron was purely the plaything of the electro-physicist but as the biologists and chemists delved more deeply into their respective sciences, they came to a point where it was convenient to express biological and chemical phenomena in terms of the electron. The electro-physicist, on the other hand, found that, in putting the electron through its paces, he was carried into the fields of biology and chemistry. So, today, we have bio-chemists and bio-physicists, both of whom must be well versed in matters of electro-physics.

In other words, there has been a gradual but constant converging of the sciences, with the electron as the ultimate meeting place. The properties of inanimate matter are already known to be due entirely to the motion and relations of electrons. Radiation, whether as heat, light, radio or x-rays, finds its source in the motion of the electron. All nervous reaction to stimulus is electrical in nature, and there is little doubt that thought—consciousness itself—is an electrical-energy manifestation.

In a recent lecture before the American Chemical Society, Prof. Bovie of Harvard showed in a startling manner, how the reaction of an amoeba to successive stimulations by light, increased as the stimulus was repeated. It appeared as though the amoeba was endowed with memory and learned to respond better as the stimulus was repeated. Prof. Bovie, however, showed that this amazing phenomena was explainable upon the basis of the hydrogen ion concentration and finally in terms of energy transfer between electrons. In a similar manner, the nature of all things in the universe is probably dependent simply upon the energy manifestations of these fundamental electrons. The mystery of life, if it will ever be solved (and there seems possibility of it) will be found to rest with the electron.

The nature of the electron itself is still the ultimate secret of nature but in the light of modern physics there is strong reason to believe that the electron is a form of energy, simply an initial distortion in space. It seems that matter in the form of electrons and energy in the form of radiation are convertible. The old concept of the indestructibility of matter is no longer unassailable. Matter, which is static, apparently can be converted into radiant energy and radiant energy may be turned into matter. Strange as this concept may appear there is evidence in the new physics to substantiate it, and more is being added each day.

Slowly, but ever more surely, we are learning. Scientific research and expanding human intellect is gradually lifting the veil of mystery that surrounds us. Man has always endeavored to do this, but today our knowledge of the electron, for the first time, furnishes us with an objective, and the ultimate measure of civilization is represented by the degree with which we can approach this objective.

Last Word in Power Plant Development

SECOND MIDWEST POWER CONFERENCE TO BE HELD AT THE COLISEUM, CHICAGO, FEBRUARY 15 TO 19

REGISTRATION for the conference will open at noon Tuesday, February 15th, at the Coliseum in the Conference room, second floor of the south hall. Nominal registration fee of $1 will be charged visitors to the Conference to cover the clerical cost of arrangements. The registration badge will admit to all meetings except the banquet on Thursday evening and to the exhibit halls at all times.

Uses of power in the industries is the main topic of the conference which will hold sessions on Tuesday

WILLIAM S. MONROE, CHAIRMAN OF THE SECOND MIDWEST POWER CONFERENCE

afternoon, Wednesday morning and afternoon, Thursday and Friday mornings. Thursday and Friday afternoons will be given to inspection trips and on Thursday evening a banquet will be held at the Palmer House, State and Monroe Sts.

The program of papers is as follows:

Tuesday afternon at 2:30 o'clock: Opening Address, The Middle West and the Power Conference, William S. Monroe of Chicago; Increasing Value of Power to Home and Industry, by W. W. Freeman of Cincinnati.

Wednesday morning at 10 o'clock: The Use of Power in Steel Mills, by Wilfred Sykes; Improvements in Heat Balance and costs in Factories of the Corn Products Refining Co., by Joseph J. Merrill; The Use of Power in the Paper Industry, by V. D. Simons.

Wednesday afternoon at 2 o'clock: A Cement Mill as a Load and Power Producer, by J. H. Lendi; Industrial Power Plant Development, by Samuel G. Neiler; The Production and Use of Power in the Packing Industry, by C. H. Kane.

Thursday morning at 10 o'clock: Economies of Coordinating Gas and Electric Power Supply, by Samuel Insull, Jr.

Friday morning at 10 o'clock: Location of and Coal for Central Power Plants, by Samuel A. Taylor; Recent Developments in Coal Burning, by F. S. Collings.

At the banquet on Thursday evening, in the Red Room of the Palmer House, an address will be given by Samuel Insull, Pres., Commonwealth Edison Co., Chicago Tickets for the banquet are $5.00, and should be purchased early in the week to make sure of reservations.

Inspection trips on Thursday afternoon will be to the Calumet Station, Commonwealth-Edison Co. and to Crane Co.'s plant on Kedzie Ave.

Those on Friday afternon will be to Peoples Gas Light & Coke Co. plant at Crawford Ave. and to South Chicago Works of the Illinois Steel Co.

Registration for these trips should be made at least 24 hr. ahead of the starting times.

EXHIBITS WILL BE COMPLETE AND VARIED

Booths are arranged in the main building and north and south halls of the Coliseum, Numbers 1 to 215 being in the main building, Numbers 300 to 340 in the south hall and Numbers 400 to 470 in the north hall. The exhibits will be open for inspection daily from noon until 10:30 p. m. starting Tuesday noon and closing Saturday night.

The Coliseum can be reached by Wabash Ave. or State St. Surface lines, also by south side elevated trains or busses.

Following is a directory, in detail of booths, exhibits and firms exhibiting:

AERO PULVERIZER CO. Booths 164-5
Unit coal pulverizer, with parts after long periods of service, and photographs of installations.
Representatives:—W. L. Martwick, F. B. Seymour, G. Parsons West, Arnold N. Dietze, H. B. Baird.

AIR PREHEATER CORP. Booth 55
Working model of Ljungstrom air preheater and exhibit of Howden air compressors and forced draft systems. Demonstration of regenerative air heating.
Representatives:—D. H. Skeen, E. T. McCarthy, E. A. Kerbey, D. A. Walker.

ALEXANDER BROS. Booth 107
Tentacular short center drive and a demonstration of absence of slip under difficult conditions.
Representatives:—H. G. Watson, Chicago manager; R. R. Liggett, C. S. Benson.

THE ALLEN-SHERMAN-HOFF CO. Booth 197
Hydrojet system for handling ashes with water collecting ash gates, quenchers, cast iron bunker and accessories.
Representatives:—James Stokoe, H. R. N. Johnson, D. H. Skeen.

ALLIS-CHALMERS MFG. CO. Booths 82-4
Reyrolle-armor-clad switch gear in operation, showing unit bus bar construction circuit breaker, feeder connection and instrument transformers. Induction motors with Timken roller bearings, self-ventilating motors with Texrope drive for short centers and models of hydraulic turbines for high and low heads and centrifugal pumps.

ALPHONS CUSTODIS CHIMNEY CONSTRUCTION CO. Booth 459
Hollow-tile chimney construction and photographs of installations.

AMERICAN ARCH CO., INC. Booth 322
Unit supported wall with air cooled supporting members; air

cooled blocks; American flat suspended arch with exposed suspension to prevent overheating.

Representatives:—J. A. Lodwick, manager industrial department; H. A. Mannshardt, Frank D. Hagen.

AMERICAN BLOWER CO. Booths 182-3

Air filter construction, details of design and methods of operation for heating and ventilating systems and for generator cooling.

Representatives:—O. B. Cahoon, power apparatus department; J. H. O'Brien, manager; J. E. McClellan, J. F. Tobin, G. W. Graham, H. R. Phelps, E. W. Peterson.

AMERICAN BROWN BOVERI ELEC. CORP. Booths 301-5

Outdoor and indoor sub-station equipment, including disconnect switches, air break switches, oil circuit breakers, switchboard and allied equipment and the mercury arc power rectifier.

Representatives:—L. J. Galbreath, advertising manager; H. D. Stier, Chicago district manager; W. H. Taubert, for the American Brown Boveri Electric Corp.; E. G. Robertson for the Railway & Industrial Engineering Co.; R. J. Neagle for the Conduit Electrical Mfg. Co.; J. J. Mullen for the Moloney Electric Co.

AMERICAN PULVERIZER CO. Booths 86-9, 124-7

Quarter scale model of American Ring crusher in operation, photographs of crushers and parts of crushing machinery.

Representatives:—Ernest E. Lee, J. L. Higgins, Chas. Hardin.

AMERICAN SCHAEFFER & BUDENBERG CORP. Booth 172

Indicating and recording gages and thermometers, tachometers, steam traps, engine indicators, gage testers, release valves, revolution counters and humidity controllers.

Representatives:—C. E. George, C. S. Kiessling, A. C. Stauch.

AMERICAN STEAM PUMP CO. Booth 34

Barton portable pump for attachment to and driving by automobiles, trucks and tractors for use in various pumping and fire fighting operations.

Representatives:—H. P. Barton, B. D. Barton, Garrett Griggs.

ANDREWS-BRADSHAW CO. Booths 189-90

Visible operation of Tracyfier under boiler conditions and sections disassembled to show construction and permit study of the operating method.

Representatives:—R. W. Andrews, L. F. Kuhman, P. H. Miner.

ARMSTRONG MACHINE WORKS Booths 403-4

Cast-iron and steel traps, sectional model of new compound trap and glass model of Armstrong trap operating on steam pressure.

Representatives:—A. E. Armstrong, president and general manager; M. F. Armstrong, vice-president; L. D. Goff, sales manager; District representatives from all the company's offices.

THE ATLAS LUMNITE CEMENT CO. Booth 328

Demonstration of the uses of Lumnite cement for quick construction and quick repairs.

Representatives:—F. J. Selinger, J. B. Cabanis.

ATWOOD & MORRILL Booth 87

Turbine and condenser valves for high temperatures and pressures, special valves for low pressure superheaters; new form of damper regulator.

Representatives:—H. E. Morrill, president; B. T. Atwood, treasurer; C. T. Atwood, secretary.

AUBURN STOKER CORP. Booth 334

150-hp. full mechanical Auburn stoker in operation.

Representatives:—B. O. Fink, president; John Fulton, chief engineer; F. A. Moreland, manager of sales; H. Fitch, assistant engineer.

AUTOMATIC PRIMER CO. Booth 122

Operating exhibit of the Apco primer for centrifugal pumps demonstrating the operation of horizontal pumps without foot valves or other means of priming.

Representatives:—F. H. Bradford, president; J. M. Wilson, treasurer; F. K. Lewis, B. M. Wolberg.

BABCOCK & WILCOX CO. Booths 147-156

Moving picture showing the way in which a Babcock & Wilcox boiler functions, a number of views of the manufacturing method used in the shops and, in addition, an exhibit of sections of forged steel headers for pressures from 200 to 1450 lb. with special forgings, such as cross boxes, drum nozzles, blowoff elbows. Rivets in various stages of manufacture, high pressure gage glasses and other items entering into the construction of the Babcock & Wilcox boilers.

Representatives:—Arthur D. Pratt.

E. B. BADGER & SONS CO. Booth 339

Self-equalizing expansion joints, Turbine center and Non-clog spray nozzles.

Representatives:—H. W. Coombs, sales manager; F. R. Heath.

BAILEY METER CO. Booths 153-6

Meter panel boards, Bailey boiler meters, fluid meters, pressure and temperature recorders, tachometers, multi-pointer gages, glass pipe model to demonstrate the operation of orifice type meter and the effect of pipe fittings on the flow of fluids, meter control system for regulating fuel and air supply according to steam demand.

Representatives:—E. G. Bailey, president; L. W. Heller, general engineer; H. M. Hammond, sales manager; W. E. East, manager, western district; R. V. Knapp, W. J. Reeder, D. S. Sample, mechanical engineers.

BARCO MFG. CO. Booth 199

Flexible joints for pipe lines and the construction of spherical packed bearings; also details of lubricated and balanced plug valves.

Representatives:—C. L. Mellor, vice-president; J. T. Ross, C. O. Jenista, S. N. Bard.

BARRETT-CHRISTIE CO. Booths 400-2

Steam traps, Instant water heaters, shovels and scoops, bearing metal, packings and gage glasses.

Representatives:—Henry Barrett, president; J. D. Christie, secretary and treasurer; Mr. White, Mr. Alston, Mr. Sprenkle.

THE BARTLETT-HAYWARD CO. Booth 460

Fast's couplings in standard and special forms with cut-away sections to show disconnecting, telescopic, water and dust proof and heavy coupling types.

Representatives:—E. G. Johnson, Chicago district manager; Hugh Benet, John Connor.

THE BAYER CO. Booth 325

Soot blowers for all types of boilers and special method for providing air circulation through the blower element when not in use.

Representatives:—C. P. Kelly, sales manager; E. H. Bull, L. J. Bayer.

SCHIEFER BEARIUM BEARINGS, INC. Booths 320-1

Rough and machined bearings for all types of service with demonstration of durability of Bearium metals for high speeds without lubrication. Cored and solid bars, special castings.

Representatives:—H. G. Pagani, president; F. A. Robertson, vice-president; W. H. Judy, vice-president and chief engineer; A. A. Matthews, J. W. Haig, A. W. Corrigan, H. R. Johnson.

R. H. BEAUMONT CO. Booths 138-9

Coal and ash handling system of a modern power plant in actual operation, receiving coal from a railroad car and discharging ash to the ash bunkers ready for loading on cars.

Representatives:—J. A. Beck, advertising manager; H. E. Birch, Western sales manager; C. C. Plummer, Chicago office; H. S. Ford, Detroit office; H. V. Schiefer, Cleveland.

BERNITZ FURNACE APPLIANCE CO. Booth 335

Illustration of the use of Carbofrax super blocks and pulverized fuel furnace lining for construction of power plant furnaces and water gas plants.

Representatives:—Arthur E. Smith, general manager; L. R. Leatherman, Chicago district sales manager.

BETHLEHEM STEEL CO. Booths 63-7

Bethlehem pulverizer, Bethlehem Dahl oil burner, turbo feed pump, Pervac extraction pump, oil engine and photographs of Diesel engines.

Representatives:—George A. Richardson, manager, technical publicity department; J. P. Madden, T. T. Bryen, P. C. Tennant, R. F. Weaver, J. C. Tobias.

THE BISHOP & BABCOCK SALES CO. Booth 448

Control board for temperature regulation, Massachusetts unit heaters, Massachusetts squirrel cage fan with Texrope drive.

Representatives:—J. C. Thompson, district manager, Chicago office; E. T. Blaker, J. E. Dafter, O. A. Klema.

BOTFIELD REFRACTORIES CO. Booth 440

Adamant fire brick cement and its uses in arch and furnace construction. Single ring arches supported by cement only.

Representatives:—Axel H. Engstrom, sales manager; W. B. Smith, refractories engineer; H. F. Krieg, manager refractories division of the Wm. E. Dee Co. of Chicago; W. B. Smith, refractories engineer.

S. F. BOWSER & CO., INC. Booth 338A

Demonstration of complete system of lubrication, oil filtration and oil storage.

Representative:—C. H. Bromley.

BOYLSTON STEAM SPECIALTY CO. Booth 41

Steam plant specialties including improved steam trap, pressure regulating valves, back pressure valves, tank valves, temperature controllers, strainers, water sprays and pump governors.

Representative:—John Boylston, H. J. Richter, J. P. Kiely, H. Nicolai.

THE BRISTOL CO. Booth 300

Complete line of recording instruments for pressure, vacuum, temperature, water level and electrical measurements. Special display of distinct-indicating water level gage for steam boilers.

Representatives:—L. G. Bean, Chicago district manager; H. A. Graf, F. W. Case, H. W. Moss.

WM. BROS BOILER & MFG. CO. Booth 426

Firebox heating boilers especially in welded type and as special feature, three- and four-drum water-tube boilers of bent tube design.

Representatives:—B. M. Bros, treasurer; A. U. Wetherbee, designing engineer; A. J. Popham, Chicago sales agent; Chester Bros.

THE BROWN INSTRUMENT CO. Booths 15-16

Electric flow meter operating on inductance bridge principle, indicating and recording instruments with circular and strip chart records for single, duplex or multiple records, CO_2 meter for boiler front or switchboard indication, pyrometers, thermometers, and pressure and draft gages.

Representatives:—G. W. Keller, sales manager; C. L. Saunders, Chicago district manager; C. E. McGregor, Mr. Conwell, Mr. Hammersley, Mr. Robinson, Mr. Gustafson, Chicago office.

BUFFALO FORGE CO. Booths 99-101

Pumps, mechanical draft equipment, ventilating and heating equipment and a combination iron worker.

THE CASEY-HEDGES CO. Booth 202

Working model of Multipass boiler, demonstrating principles of operation, and photographs of installations.

Representatives:—W. A. Day, Chicago district sales manager; L. H. McGowan, Chattanooga; Mr. Forsyth, Milwaukee.

A. W. CASH CO. Booth 185

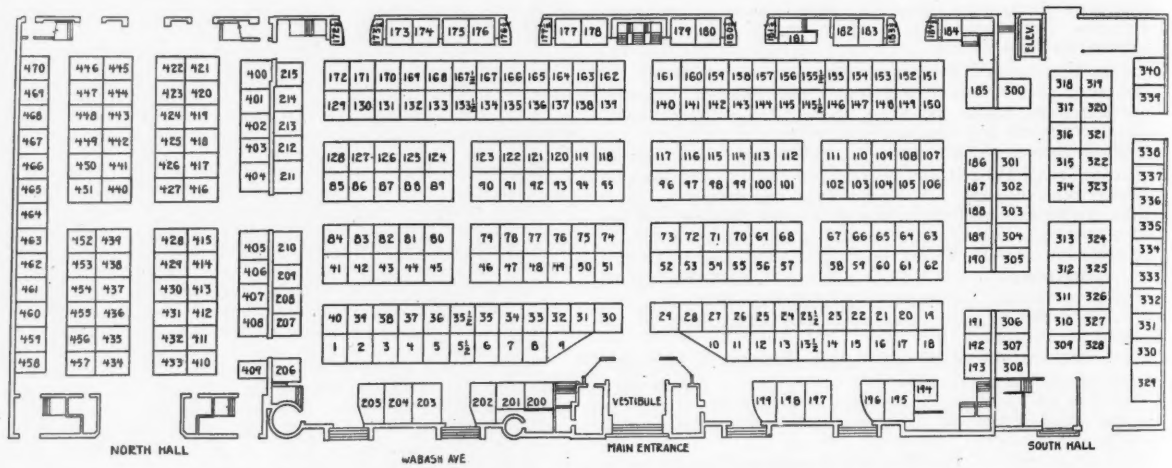
Craig system of automatic combination control with master controller for fans, stoker engines and stack dampers. Models of pressure regulating valves and pump governors.

Representatives:—C. W. Court, V. A. McKechnie.

CELITE PRODUCTS CO. Booth 453

Demonstration of difference in conductivity through insulated and un-insulated wall construction with sample furnace walls, blue prints, charts and display of Sil-O-Cel insulating brick, Celite air sealing compound and Fraxite refractory cements.

Representatives:—C. M. Smith, advertising manager; C. A. Frankenhoff, central division sales manager; Stephen Mahon, assistant; H. L. Haberstroh, T. E. Ventriss, N. E. Baxter, R. V. Massman, sales engineers.



PLAN OF THE COLISEUM SHOWING BOOTH NUMBERS AND THEIR LOCATION

Representatives:—F. Frankel, Buffalo, N. Y.; C. Cheyney, C. Emmert, H. Dunbar, Chicago office; F. Stubinger, Buffalo.

BUILDERS IRON FOUNDRY Booth 168

Venturi meters of registering, indicating and recording types in operation, barometric manometer, details of Venturi tubes and Venturi nozzles.

Representatives:—W. D. Hess, G. H. Jewell.

BUNDY STEAM TRAP CO. Booth 432

Complete line of steam traps with demonstration of new improvements to eliminate vibration, give simplicity and reduce friction.

Representatives:—E. M. Stevens, vice-president and sales manager; Charles W. H. Herbert, chief engineer and plant superintendent.

BURKE ENGINEERING CO. Booths 120-1

New underfeed stoker, traveling grate stoker, hand operated stoker and U. S. rocking grate.

Representatives:—E. W. Ritter, president; S. L. Arson, J. B. Grigg, W. C. Smith, F. V. Herdman, C. J. McLean, W. T. Ritter.

BURNHAM, BLAND & LINDSEY Booths 435-8

Vulcan soot cleaners and operating heads, Ross guided expansion joints and oil vapor condensor, Moore centrifugal pumps and steam turbines, Centrifix steam purifying apparatus, Smith gas engines and producers.

Representatives:—Henry Bland, C. L. Burnham.

CARRICK ENGINEERING CO. Booth 195

Master control system for regulation of furnace demonstrated in a glass enclosure to show action of the mercury control.

Representatives: — G. F. Carrick, John H. Hillmeyer, John Erwood.

CARTER BLOXONEND FLOORING CO. Booth 167

Flooring panels made up of the special Bloxonend material and illustration of the method of laying over old floors of any material.

Representatives:—A. E. Giese, manager Chicago office; John Thomasma, superintendent of construction, Chicago; L. L. Bucklew, manager, Detroit office; J. G. Galvin, advertising manager.

CENTRIFIX CORP. Booths 173-4

Apparatus for centrifugal separation of moisture from steam and compressed air and of dust from air and gases.

Representatives:—C. G. Hawley, O. P. Warner, George von Haase, L. C. Kerner, Burnham, Bland & Lindsey, Inc.

THE CHAPMAN VALVE MFG. CO. Booths 5-5½

Steel gate valves and fittings for high pressures and temperatures, Chapman motor unit for valve operation with working demonstration, iron body and brass valves for water, steam and general service, reports of research on power plant materials.

Representatives:—F. S. Kiley, J. T. Mulgrew, Frank Boch, C. J. Burrage, V. T. Malcolm, E. C. Gilbert.

CHICAGO CHEMICAL CO. Booth 108

Demonstration in glass model boiler of water treating by K. W. S. Sodium Aluminate and display of water testing equipment.

Representatives:—F. H. Thorne, J. A. Holmes, D. L. Donnelly, H. A. Kern, A. E. Warner.

CHICAGO CONCRETE BREAKING CO. Booth 180½

CHICAGO PUMP CO. Booths 203-4

Flush-Kleen sewage ejector in operation, pumping units, multistage horizontal pumps, vertical pumps and heating pumps units.

Representatives:—M. I. Weil, N. H. Weil, A. C. Durdin, G. F. Mannion, C. J. McCann, R. D. Elliott.

CHICAGO RHOPAC PRODUCTS CO. Booth 445

CLARAGE FAN CO. Booths 175-6

Air washer, heating and ventilating fans, high-speed, forced draft fan, steam engine for operating stokers and other accessory equipment, blast gates, dampers, ventilators and exhaust fans.

Representatives:—Charles Clarage, president; L. O. Monroe, general manager; R. W. Wilson, sales manager; C. R. McConner, A. H. Colbert, H. H. Valiquet, F. D. Lawrence, W. F. Schlichting, Chicago office.

CLEVELAND WORM & GEAR CO. Booth 444

Worm gear reduction units, samples of worm gears and bearings.

Representatives:—Howard Dingle, vice-president and general

manager; F. E. Bardrof, advertising manager; W. W. Clark, Cleveland office; F. J. Page, R. E. Ludwick, Chicago office.

CLIPPER BELT LACER CO. Booth 340
Time-saving belt lacing products, including Clipper belt lacers, hooks, cutters and connecting pins. Special feature will be No. 8 speed lacer just announced to the trade.
Representative:—George Farmer.

COCHRANE CORP. Booths 446-7
Deaerating heaters for all pressures, flow meters, multiport back pressure valves, separators, high-pressure and low-pressure traps.
Representatives:—H. E. Sibson, general sales manager; P. S. Lyon, chief engineer; A. B. Wallem, general works manager; J. D. Yoder, head of water softener and filter department; Austin Dresher, C. B. White, C. Schmur, Mr. Elder, Chicago; Frederick H. Mason, P. J. Berry, P. F. W. Timm, Detroit; Irvin C. DeHaven, R. L. Nessler, Indianapolis; H. P. Thompson, R. Schrimp, W. S. Cooper, Cincinnati; N. Stewart, B. Roth, St. Louis.

COKAL STOKER CORP. Booths 129-31
Pulverzone stokers with separate zones for burning lumps and fine coal.
Representatives:—George A. Kohout, D. A. Campbell, T. W. Lietz.

COLUMBIA VARI-SPEED CO. Booth 173½
JFS variable speed transmissions in operation with speed variation of 40 to 1, also detailed parts and other units in operation.
Representatives:—M. D. French, treasurer; L. A. Knaus, H. Schlotthauer, R. S. Jacobsen.

COMBUSTION ENGINEERING CORP. Booths 8-9, 30-33
Lopulco furnace and boiler unit, Combustion steam generator, Couch burner for horizontal firing of pulverized fuel, unit system pulverizing mill with cyclone separator, Green forced draft stoker, C-E air heater and C-E fin furnace. Photographs and drawings of steam generating units and specially designed furnace and boiler units.
Representatives:—R. C. Beadle, Charles McDonough, T. A. Marsh, W. R. Wood, T. A. Adams.

COMMONWEALTH EDISON CO. Booth 112

CONDIT ELECTRICAL MFG. CO. Booth 302
Oil circuit breakers for 15,000-v. service, motor circuit panel with oil motor starter, control relays for air or oil circuit breakers.
Representative:—Paul W. Koch & Co.

CONNERY & CO. Booths 116-7
Connery's improved expansion stiffener for smoke breechings, air cooled damper and special method for supporting and applying asbestos covering to breechings.
Representatives:—W. M. Connery, A. D. Stewart, W. J. Henderson, W. E. Gaunt, A. H. C. Dalley.

COOKE SEAL RING, INC. Booth 172½
Demonstration of the construction and method of action of the mechanical device for packing rods and rotating shafts.
Representative:—George J. Cooke.

COPPUS ENGINEERING CORP. Booth 21
Undergrate draft turbo blowers and Vano blowers either steam turbine, air turbine or electric motor-driven for stoker or pipe line draft.
Representatives:—Harry Himbelblau, T. S. Agazim.

CRANDALL PACKING CO. Booth 205½
Crandall packings in sheet, rod and gasket form for all services.

CRANE CO. Booths 1-2
Forged steel valves, fittings and flanged unions, valves with stainless steel trimming for extreme high pressure and temperature.
Representatives; — M. W. Link, George Wright, Malcolm Baxter.

CRANE PACKING CO. Booth 434
Use of metallic packing for condenser tubes and the method of changing from tubes packed at both ends to tubes expanded at one end and packed with metallic packing at the other. Metallic packings for steam, air, ammonia, hot oils, gasoline and other service.
Representatives:—F. E. Payne, George Ayrscott, J. N. Walton, A. W. Payne, D. B. Grasett.

CROSBY STEAM GAGE & VALVE CO. Booth 179
Three-inch, nozzle-type safety valve for 1500 lb. steam pressure, in sectioned form. This design is as used at the Kearney Station, Hellgate Station and Colfax extension. Also new design fluid pressure scale for testing gages up to 3000 lb. with reading directly from the scale and without the use of dead weights. Standard gages, indicators, globe valves and like specialties.
Representatives:—George F. Felker, vice-president; L. W. Lenderolph.

THE CUTLER-HAMMER MFG. CO. Booths 312-13
Automatic overload starter, across the line starter, drum equipment for the control of forced draft fans, Dean system of valve control in operation, display of building equipment apparatus, space heaters, tubular heaters and the like.
Representatives:—C. J. Maloney, B. Steel, A. R. Johnson, G. M. Arnold, F. J. Burd, K. O. Swanson, J. E. Middlekauff.

THE CUTTER ELECTRICAL & MFG. CO. Booths 310-11
6000-amp. 3-pole carbon circuit breaker, non-closable on overload; 600 and 1000-amp. circuit breakers for a. c. service; 3000-amp. single-pole toggle switch, 800-amp. single-pole circuit breaker; 60-, 150- and 1250-amp. U-Re-Lites.
Representatives:—E. Swift Newton, vice-president; O. M. Bercaw, T. R. Routh, I. S. Allen.

G. M. DAVIS REGULATOR CO. Booth 45
Full sized models of valve specialties including pressure regulators, float valves, back pressure valves, stop and check valves and steam traps.
Representatives:—George C. Davis, president; J. C. Kinsley, secretary; G. J. Hachmeister, C. L. Swanson, H. R. Willard, R. Peterson.

THE DELAVAL SEPARATOR CO. Booths 134-5
Oil purifying apparatus for the handling of turbine oil and dehydration of transformer and circuit breaker oil.
Representatives:—C. B. Schmidt, manager industrial department; H. C. Beckman, R. G. Walker, N. E. Larsen, H. M. Beach, A. R. Rose, C. C. Reeder, E. H. Croisant.

DELTA STAR ELECTRIC CO. Booths 316-17
Unit type standardized sub-stations with steel towers, choke coils, mountings and switching units.
Representatives:—A. Alsaker, E. J. Thompson, G. F. Maddox, W. H. Boyce, R. E. Anderson.

M. H. DETRICK CO. Booths 149-50
Sectionally supported side walls for pulverized fuel furnaces, Detrick flat suspended arches and photographs of installations of various plants for different types of boilers.
Representatives:—L. H. Hosbein, R. C. Warner, P. F. Hegerty, Tom Vaughn, L. Ryan, F. I. Sheahan, C. F. Pollen.

DETROIT STOKER CO. Booths 177-8
Full size underfeed stoker in operation with worm gear drive and controlled stroke of the pusher rod.
Representatives:—W. H. Rea, president; W. H. Riecks, secretary and works manager; R. L. Beers, chief engineer; F. B. Strale, director of sales; E. L. Beckwith, Chicago office; Robert June, publicity director; L. I. Snodgrass, Cincinnati; Fred Williams, Cleveland.

DEWALT PRODUCTS CO. Booth 25
Wonder worker for portable use in wood working.
Representatives:—F. Gardner, Burt B. Barry.

DIAMOND POWER SPECIALTY CORP. Booths 140-1
Miniature boiler showing correct application of soot blowers for varying boiler conditions and effect of soot deposits in retarding heat transmission. Motion picture films showing benefits of soot blowers on oil-fired boilers used by U. S. Navy.
Representatives:—W. P. Thomas, C. L. Conrad, L. E. Trotter, Fred Clasmann, G. L. Davis, M. J. Miller, M. M. Stone, F. W. Goldsmith, E. K. Uebe, Frank Bowers, B. G. Proetz, Robert June.

DINGS MAGNETIC SEPARATOR CO. Booth 126
System for separating iron and steel from coal and other material, also details of system for magnetic concentration of ores.

JOS. DIXON CRUCIBLE CO. Booth 12
Graphite products, including paints, belt dressing, greases, pipe joint compound and other special applications. Demonstration by a machine built to show temperature and load on bearings.
Representatives:—E. C. Bleam, P. H. Griffin.

DODGE MFG. CORP. Booths 418-20
Dodge-Timken conveyor idlers, belt governors and loose pulleys. Roller bearing pillow blocks, hangers and new developments in material handling field.
Representatives:—

C. A. DUNHAM CO. Booths 455-6
Specialties for heating systems, traps for low and medium pressures and damper control systems.
Representatives: — Christian A. Thinn, Clare M. Brigham, Bruce H. Jarvis, Macy S. Good, Leslie W. Millar.

THE EDWARD VALVE & MFG. CO. Booth 52
Forged steel valves, screwed and flanged end designs and with union and bolted bonnets; Ferac non-return valves. This company invites visitors to the Power Show to visit its works at East Chicago, Ind. Arrangements can be made with attendants at the company's booth.
Representatives:—W. W. Crawford, president; O. M. Norby, vice-president; H. A. Pearson, works manager; J. E. McDonald,

sales manager; J. F. Hallowell, assistant to sales manager; D. H. Skeen, E. A. Kerbey, Chicago representatives.

EHRET MAGNESIA MFG. CO. Booth 43

Illustration of 85 per cent magnesia and special high temperature insulation in special and block form, also the processes of manufacture.

Representatives:—Lawrence L. Shailer, H. G. Hill.

ELECTRICAL DEVELOPMENT MFG. CO. Booth 303

ELECTRICAL ENGINEERING EQUIPMENT CO. Booth 338

ELGIN NATIONAL WATCH CO. Booth 186

The tachometer division of this company will exhibit flexible drive equipment and Elgin chronometric tachometers, the flexible drive being the product of the Biax Flexible Shaft Co. of N. Y.

Representatives:—Gordon C. Gillies, manager tachometer division; Lloyd A. Laflin, assistant manager tachometer division.

ELLIOTT CO. Booths 105-6

Strainers, separators, preheaters, deaerators, 100-kw. geared turbine-generator set, boiler tube cleaners and other specialties.

Representatives:—H. A. Pastre, M. C. Sickels, F. A. Calmus, F. T. Cooper, C. H. Swett, R. K. Williams, C. L. Draper, F. C. Angle, C. F. Harms, E. W. Butler, F. S. Hickok.

LEWIS M. ELLISON Booths 200-1

New pointer draft gage, new U-path calorimeter, complete line of inclined and vertical draft gages.

Representatives:—Lewis M. Ellison, Henning L. Hultman.

EVENS & HOWARD FIRE BRICK CO. Booth 166

Complete line of straight and special shape fire brick in the various brands of the company's manufacture.

Representatives:—R. M. Sievers, vice-president; F. W. Dyer, Chicago district sales manager; C. D. Ellis, D. L. Haley, N. H. Jacobsen, A. F. Eilenberger, Chicago; J. H. Lovett, Detroit.

EVERLASTING VALVE CO. Booth 40

Everlasting companion angle, regular Everlasting blow-off valve, Everlasting tandem valve Model X, Flat-plug valve, the Boiler Draw-off Wylie Wilson process.

Representatives:—John H. Allen, president; W. H. Harrower, assistant engineer; George M. Elton, Jr.; Charles Heggie, president, Scully Steel & Iron Co.; George Mason, vice-president; J. W. Patterson, Ray Siewert.

FAFNIR BEARING CO. Booths 337-8

Industrial ball bearings in various applications; also radical and thrust bearings, pillow blocks and running demonstration of low friction loss.

Representatives:—R. N. Hemenway, vice-president; H. Reynolds, chief engineer; C. W. Kramlich, T. C. Waddell, T. Fisk, R. M. Ring.

FAIRBANKS, MORSE & CO. Booths 94-5, 118-9

Diesel engine generating set, squirrel cage and direct current motors in operation, centrifugal pump in operation and sectioned models to show construction.

Representatives:—C. W. House, E. Chambers, R. V. Cook.

THE FISHER GOVERNOR CO., INC. Booth 410

Pump governors, reducing valves, traps and liquid level controllers.

Representatives:—L. W. Browne, vice-president; O. M. Galiher.

FOSTER ENGINEERING CO. Booth 459

Pressure regulators, pump governors for high pressure service, back pressure and relief valves, float valves, automatic stop and check valves and non-return types, fan engine regulators, flexible ball joints and the Foster sight flow box.

Representatives: — Charles A. Olson, president and general manager; George H. Bauer, Chicago office manager; William E. Heck, assistant sales manager Chicago; M. S. Maleson.

THE FOXBORO CO., INC. Booth 26

Test and demonstration of the accuracy of Foxboro thermometers and helical movement under overload and severe temperature conditions. Boiler water level gage in operation, flow meters, flow controllers and other Foxboro instruments.

Representatives:—C. H. Roessner, manager, Chicago office; J. J. Burnett, W. R. Reitz, C. L. Nowland, R. L. Stewart, C. F. Hayden, Ross N. Perkins.

O. E. FRANK HEATER & ENGINEERING CO. Booth 22

Full sized heat exchanger and oil cooler disassembled to show construction, also U-tube type storage heater.

Representatives:—Olive E. Frank, president; Herbert P. Wilder, Buffalo office.

FULLER-LEHIGH CO. Booths 145-8

Pulverizer mills, vertical driers, coal burners, water-cooled furnace walls, Fuller-Kinyon pump for handling pulverized fuel, single screw feeder, Calumet pulverized coal burner, Bailey feeder and meter and photographs of installations.

Representatives:—E. G. Bailey, E. J. Billings, L. W. Marso, H. D. Lehr, R. A. Hawk.

FURNACE ENGINEERING CO. Booths 78-9

Simplex system of unit pulverization with air separation, electric drive and magnetic separator.

Representatives:—A. B. Carle, assistant sales manager; E. B. Priebe.

GENERAL ELECTRIC CO. Booths 74-77

Flow meters, motor and control equipment, air cooling for turbine generators, mechanical turbine.

Representative:—W. A. Gluesing.

GRAVER CORP. Booth 123

Working model of water softening plant and colored drawings of details of apparatus and installations.

Representatives:—J. J. Felsecker, W. M. Gross, E. S. Thayer, J. C. Winslow.

GRINDLE FUEL EQUIPMENT CO. Booths 70-3

Unit pulverized coal system and methods for drying and feeding pulverized coal; also standard pulverized coal burner.

Representatives:—R. H. Bourne, president; A. J. Grindle, vice-president; Joseph Harrington, M. F. Becker, C. R, Taylor, J. R. Mansfield, R. S. Higgins.

GRISCOM-RUSSELL CO. Booths 430-1

Reilly evaporators, water heaters, multi-well oil coolers, U-fin air coolers, steam and air separators, G-R bent tube evaporators.

HAGAN CORP. Booths 27-28

Steam purifiers, combustion controller, test cabinets, concentration gages and a central control system for operation of individual boilers from a single panel.

Representatives:—T. A. Peebles, chief engineer; D. J. Erikson, sales manager; A. G. Burke, Jr., R. E. Busch, Chicago; Joseph H. Spurgeon, Detroit; F. H. Schubert, St. Louis; Leopold Pistner, St. Paul.

JOSEPH HARRINGTON CO. Booths 70-3

King Coal automatic mechanical stoker for boilers from 40 to 250 hp. with front over-feed, step grate stoker and automatic action.

Representatives:—Joseph Harrington, president; R. H. Bourne, vice-president; J. R. Mansfield, H. Logan, R. S. Higgins, E. J. Friedrick, J. M. Grubbs.

ARTHUR HARRIS & CO. Booth 181½

Coils and bends of copper and brass pipes, with floats for pressures up to 150 lb., expansion joints for vacuum and low pressure, balanced valves for use with feed water heaters and tanks.

THE HAYS CORP. Booth 324

Pointer type gages with illuminated scales, automatic CO_2 and draft recorders, improved flue gas analyzer and portable combustion testing kit.

Representatives:—P. T. Sprague, president; Otto Ziegler, works manager; Arnold Soller, designing engineer; J. W. Murphy, J. T. Vollbrecht, P. D. Armstrong of the J. W. Murphy Co.

HIMELBLAU, AGAZIM & CO. Booths 21-22

Ames engines, boiler baffles, smoke indicators and liquid level gage, blowers, pumps and turbines, cork isolation, steam specialties and packings.

Representatives:—Harry Himelblau, T. Agazim, H. E. Jensen, F. J. Murray of Himelblau, Agazim & Co., J. W. Putnam of the Boiler Engineering Co., C. E. Craig of the Liberty Electric Corp., S. Rosensweig of the Korfund Company.

THE M. A. HOFFT CO. Booth 187

Moving pictures of the repair of an arch and the cleaning of clinkers and ash from a stoker, also details of grate bars, stoker and arch.

HYDRAULIC PRESS MFG. CO. Booths 13½-14

"Forg steel" fittings and valves for high pressure and temperature with special design to give full steam opening, body of uniform section and renewable disc and seat. Semi-automatic high and low-pressure operating valve for hydraulic presses; high-pressure reducing valve; high-pressure motor-driven pump with automatic regulation.

Representative:—Paul C. Pocock, general sales manager.

ILLINOIS ENGINERRING CO. Booths 405-6

Glass operating model of Eclipse steam trap under working conditions showing opening and closing of the valves and extreme separation of valve from seat, also complete line of steam and vapor specialties.

Representatives:—J. L. Matchett, J. L. Ehretsman, L. Bandet, F. Goodspeed, L. J. Pitcher, W. T. Walters.

INGERSOLL-RAND CO. Booths 450-51

Cameron pumps, boiler feed pump for pressures up to 1500 lb. with new thrust balancing device, hotwell and condensate pump with double opposed impellers to avoid air infiltration, surface

condensers showing tube staging, proportioning of steam flow areas, separate air devaporization and cooling and control of longitudinal steam distribution.

Representatives:—J. D. Cone, J. F. Kenney, H. S. Budd, L. P. Scantlin, A. B. Steeves, T. O. Price, C. K. Wildman, H. John.

INSTANT WATER HEATER CO. Booth 401

Special water heaters for power plant use.

Representatives:—Messrs. Prizer, Yoder, White, Olson and Sprenkel.

INTERNATIONAL FILTER CO. Booth 427

Working model of the new International steam purifier for installation in steam drums of boilers.

Representatives:—P. N. Engel, president; W. J. Hughes.

THE INTERNATIONAL NICKEL CO. Booths 212-13

Monel metal and pure nickel in commercial forms and a collection of sample parts of power plant equipment made from these materials.

Representatives:—L. Muller-Thym, R. E. Mason, New York; H. B. Dickinson, W. J. Kirk, Chicago; R. B. Nation, Pittsburgh.

IRVING IRON WORKS Booth 433

Safstep construction in standard form and special construction with Vizabledge for added safety.

Representatives:—E. Brodhead, sales manager; J. H. Miller, F. C. Yale, William Noblett, sales engineers.

JENKINS BROS. Booth 290

Globe, angle, check and gate valves of bronze and iron construction, radiator valves and quick acting valves. Mechanical rubber goods and Moncrieff gage glasses.

Representatives:—H. B. McLelland, H. A. Taif, George Davidsen.

JEWELL ELECTRIC INSTRUMENT CO. Booth 323

Electrical measuring instruments of portable and panel type for industrial, radio and power plant use.

Representatives:—George H. Koch, E. E. Stolp.

JOHNSON SERVICE CO. Booth 442

Automatic control system for heating and ventilating and details of the apparatus.

Representatives:—P. A. Riccis, Frank B. Brophy, Victor M. Lathers.

W. A. JONES FOUNDRY & MACHINE CO. Booth 128

Worm and spur gear speed reducers for all ratios of speed reduction.

Representatives:—W. S. LaScelle, L. C. Meyer, J. A. Marland.

KELLEY VALVE CO. Booth 23

Self-grinding globe and angle valves and valve controllers.

Representatives:—P. J. Kelley, H. Himelblau, T. Agazim, A. E. Jacobson.

THE M. W. KELLOGG CO. Booth 54

Swivel and fixed type of flanged joints, forged and welded nozzles and headers, Van Stone joints and Kellogg copper plated welded expansion joints.

Representatives:—D. H. Skeen, E. A. Kerbey, E. T. McCarthy, D. A. Walker.

KIELEY & MUELLER, INC. Booth 401

Sectioned views of valves for pressure regulation, stop and check valves and high pressure return trap.

Representatives:—C. H. Dutcher, manager; C. M. White.

THE KORFUND CO. Booth 21

Korfund plates for foundation work to eliminate vibration, also Vibro-dampers for deadening vibration and noise.

Representatives:—S. Rosenzweig, vice-president; H. Himelblau, T. S. Agazim.

THE LABOUR CO. Booths 469-70

Self-priming centrifugal pump for permanent and portable use with a pump having glass suction lines in operation to show the self-priming feature and the ability to handle air.

Representatives:—H. E. LaBour, N. A. Pederson, C. A. Stephenson, L. Jarmie.

LADD WATER TUBE BOILER CO. Booths 8-9

Construction and arrangement of various types of water tube boilers and superheaters and the arrangement of special baffle tile.

Representatives:—George T. Ladd, F. N. Connally.

LAMONT CORP. Booth 205

Steam generators with film evaporation, Duplex steam sealed valves.

Representatives:—William J. Norton, John B. Scheel, Thomas Tompolsky, William S. Anderson, Jr., Gardner W. Wood.

THE LEAVITT MACHINE CO. Booth 125

Valve-reseating machine for globe and gate valves and pump valve seats.

Representative:—E. S. Hersey.

ERNEST E. LEE CO. Booths 86-9, 124-27

Coal crushing and separating equipment, centrifugal pumps, ash handling systems, valve reseating machines, feed water control, recording and indicating instruments, preservative tanks.

Representatives:—Ernest E. Lee, J. L. Higgins, J. L. Mayer, F. E. Oswald.

LIBERTY ELECTRIC CORP. Booth 306

Liberty valve operators on 6-in. high pressure valves, both push-button and manually operated with demonstration of safety clutch and cut-out control.

Representatives:—Chas. A. Craig, sales manager; Joseph McKay, Jr.

GEO. B. LIMBERT & CO. Booths 92-3

Pipe bands, pipe line material, cast steel fittings and valves.

Representatives:—D. C. Showers, vice president; M. R. Paulson, F. Lynch.

LINK-BELT CO. Booths 463-5

Coal and ash handling systems, storage and reclaiming of coal, silent chain drives, water intake screens, skip hoists and elevating and conveying machinery for all classes of work.

LIPTAK FIREBRICK ARCH CO. Booths 143-4

Section of Liptak air-cooled furnace walls and solid furnace wall construction; model of Liptak double suspension arches, self-supporting walls of all refractory construction.

Representatives:—George E. Ford, vice-president; J. Harrison Brown, sales manager; W. H. Boyd, H. E. Sharp.

LOCKE REGULATOR CO. Booth 432

Damper regulator, reducing and balanced valves, stop and speed limit system; pilot valve control of the damper regulator system demonstrated in operation.

Representatives:—F. R. Eliason, superintendent; W. A. Heaney, assistant superintendent.

J. E. LONERGAN CO. Booth 432

Steam specialties, including safety valves, relief valves, gages, clocks, water gage fittings and chime whistles.

Representatives:—A. St. C. Tomes, vice-president; Fred S. Hickey, Charles Naylor, Al Berteaux, A. T. Rosenow.

THE LUNKENHEIMER CO. Booths 136-7

Steel, monel, iron and bronze valves for pressures of 900 lb. and all monel gate, globe and check valves for 400 lb. pressure. Steel monel mounted gate valves with Dean and Liberty electric control.

JOHN W. MABBS Booths 49-50-51

MAGNETIC MFG. CO. Booth 443

MANISTEE IRON WORKS CO. Booth 88

Roturbo pumps in multi-stage and single stage form; details of Roturbo impeller.

Representatives:—D. J. Rowland, E. S. Quakenbush, A. P. Olches.

MANNING, MAXWELL & MOORE, INC. Booths 19-20

Ashcroft steam gages, Consolidated safety valves, Metropolitan injectors and Hancock valves.

Representatives:—W. B. Bradbury, sales manager; W. E. Jerauld, works manager; William Loos, E. L. Berthold, Charles Stepan, A. G. Marshall, J. Hamilton, F. G. Geyer.

MARION MACHINE, FOUNDRY & SUPPLY CO. Booths 407-8

Soot blowers with independently operated valve in the head with demonstration of their action in water tube boilers; also Gulf stream water heater for supplying large quantities of hot water.

Representatives:—A. L. Bolinger, Edward Beal.

MERCO NORDSTROM VALVE CO. Booth 157

Merco Nordstrom lubricated plug valves, in two-way, three-way and four-way types, and of iron, steel and nickel bronze construction.

Representatives:—D. N. Whitlock, Chicago manager; F. Hammett, C. Wyman, sales engineers.

THE MERCON REGULATOR CO. Booth 52

Pressure regulators of all types up to 900 lb. and 750 deg., also pump governor for steam-driven boiler feed pump operating at 900 lb.

Representatives:—D. H. Skeen, D. S. Walker.

MERRICK SCALE MFG. CO. Booth 308

Operation of conveyor scales in weighing out actual material, also demonstration of the Merrick Mechanical Weighman for giving accurate record of loads.

Representative:—F. P. Hambright, sales manager.

MIDWEST PIPING & SUPPLY CO. Booth 161

Special pipe joints which do not require gaskets or field welding but will handle steam up to 900 lb. pressure and 750 deg. temperature. Results of tests on special processed Van Stone and

Midwest joints. Welded header for 900 lb. pressure with Van Stone, Sargol and Midwest nozzle joints.
Representatives:—J. McC. Moffett, secretary; Paul F. Witte, advertising manager.

MILWAUKEE RELIANCE BOILER WORKS Booth 50
Reliance feed water heaters and steel tank construction.
Representatives:—J. J. Hayes, A. O. May.

MODINE MFG. CO. Booth 183½

MOLONEY ELECTRIC CO. Booth 301
Transformers and transformer equipment.
Representative:—J. J. Mullen.

MOORE STEAM TURBINE CORP. Booth 436
Multi-stage boiler and feed pump, turbine driven and oil relay governor operating by hydraulic action. Double helical reduction gears.
Representatives:—M. D. Church, president; George R. Probst, sales manager; C. L. Burnham, Henry Bland, Chicago representatives.

THE J. W. MURPHY CO. Booth 324
Rowan automatic motor starters operating a fan under various starting loads, with Esterline meters to show starting characteristics. Hays CO_2 and draft recording apparatus and diaphragm draft gages.
Representatives:—J. S. Rowan, Phillip Sprague, J. W. Murphy, M. J. van Leeuwen, P. D. Armstrong, C. J. Westhoven, J. T. Vollbrecht.

NASH ENGINEERING CO. Booths 49-51
Jennings Hytor vacuum and low-pressure boiler feed pumps, centrifugal pumps, sewage ejectors, low-pressure compressors and condensation pumps.
Representatives:—J. M. Stannard, G. W. Clucas, R. L. Sutherland, H. C. Crane.

NATIONAL POWER CONSTRUCTION CO. Booth 452
Photographs of boiler settings and details of construction of plants installed.
Representatives:—Glenn E. Reynolds, Mr. Scheying.

NATIONAL TUBE CO. Booth 457
Seamless tubing, boiler tubes, scale free pipe and Van Stone flanges.
Representative:—W. L. Shaffer.

NATIONAL VALVE & MFG. CO. Booth 127
Fabricated piping equipment and Navco pipe joints for high steam pressures, also pipe supports and methods of welding headers.
Representatives:—J. S. Land, Pittsburgh; Ernest E. Lee, C. M. Hardin, Chicago office.

NAYLOR-HICKEY CORP. Booth 432
Bundy steam traps in return, separating and pumping forms, Lonergan steam specialties, including safety valves, oil cups, whistles and gages; Locke damper regulators and engine stops.
Representatives:—Charles E. Naylor, Fred S. Hickey, A. J. Bertaux, W. F. Ebert, A. T. Rosenow.

NICE BALL BEARING CO. Booth 425
Industrial ball bearings in all types and an industrial ball bearing castor with pressed steel block for carrying heavy loads.
Representatives:—Ralph Woods, Mr. Lescure.

NORMA-HOFFMAN BEARINGS CORP. Booths 3-4
Norma precision ball bearings, Hoffmann precision roller bearings and thrust bearings, demonstration of creep of outer or inner rings when the other one is revolving.
Representatives:—O. P. Wilson, Norman Bell, D. E. Batesole, T. J. Harley, C. A. Wallace, T. M. Kaino.

NORTHERN EQUIPMENT CO. Booths 86-9, 124-7
Copes feed water regulator showing its action; condensate drainage control system complete; B. I. A. control valve and method of adjusting size of valve ports; pump governor, water level indicator.
Representatives:—E. W. Nick, president; C. E. Wolff, Jr., E. E. Lee, J. L. Higgins, C. M. Hardin, T. E. Shaughnessy of Ernest E. Lee Co.

R. D. NUTTALL CO. Booth 104
Toughhard gears and pinions for power machinery and industrial use.
Representatives:—J. E. Mullen, C. H. Doolin.

NUWAY BOILER & ENGINEERING CO. Booth 188
Operating glass model of the Nuway super-circulation boiler, photographs of actual installations and of the Nuway boiler water walls, also section header of the walls.
Representatives:—P. G. Kaiser, president; E. A. Kaiser, secretary and treasurer; L. W. Dunbar.

THE S. OBERMAYER CO. Booths 467-8
Refractory materials for furnace construction, high-temperature furnace cements, plastic furnace lining and results obtained by its use.
Representatives:—George F. Doyle, F. C. Corley, F. U. Skeggs, I. L. Cummings, J. L. Clarke.

PAGE & LUDWICK Booths 443-4
Flexible Couplings, worm and gear drives, Magnetic separators, all in working models.
Representatives:—Mr. Page, Mr. Ludwick.

PEABODY COAL CO. Booth 331
This booth will be used for the accommodation and convenience of visitors at the show and all visitors are invited to make use of its facilities.
Representative:—W. F. Royce, advertising manager.

PEABODY ENGINEERING CORP. Booth 424
Construction and installation for oil, gas and pulverized coal burning equipment and for viscosity regulators. Combined coal and oil burner. Large capacity coal burner.
Representatives:—D. P. Graham, J. P. Leask, New York office; J. J. Somes, Chicago representative.

PENNSYLVANIA CRUSHER CO. Booth 198
Coal breakers, single roll crushers and photographs of installations with details of crushing machinery.
Representatives:—C. S. Darling, J. A. Plimpton.

THE PERMUTIT CO. Booth 180
Model of water softening and filtering equipment as used in industrial plants, showing the zeolite method of treatment for large and small plants. Renarex CO_2 recording apparatus.
Representatives:—F. S. Dunham, H. P. Sherwood, I. J. Bready, R. S. Ellis, J. H. Murphy.

PITTSBURGH PIPING & EQUIPMENT CO. Booths 98-115
Examples of welded pipe manifold, headers, cast steel manifold, line welds and various types of flange joints.
Representatives:—Robert Whyte, general manager of sales; Berford Brittain, Thomas N. Bishop.

PLIBRICO JOINTLESS FIRE BRICK CO. Booths 90-91
Moving pictures showing the installation of monolithic lining under 250-hp. boiler. Construction of monolithic Plibrico wall and use of the flexo-anchor between the refractory and common brick.
Representatives:—I. S. Pieters, vice-president; Wm. A. Schaefer, J. E. Anderson, I. Kuttnauer, Charles Peacock, A. Macdonald.

WM. A. POPE Booth 85
Piping system construction, heating specialties and photographs of large piping installations.
Representatives:—William A. Miller, R. A. Widdicombe, S. Austin Pope.

THE WM. POWELL CO. Booth 449
Bronze, iron, steel valves in all forms and for high and low pressures. Greasing and lubricating devices, water and oil gages, and other brass specialties.
Representatives:—E. F. Smith, E. M. Gallagher, Chicago factory representative; William Heilig, E. Boehringer.

POWER PLANT SPECIALTY CO. Booth 206
Photographs and blueprints of water softening plant, also a wet feed and a dry feed type of water proportioner showing the method of driving by means of duplex piston water motor which also serves for pump for chemical solution and gives record of the water passing through.
Representatives:—W. H. Stevenson, president; M. B. Peirson, secretary.

POWERS REGULATOR CO. Booth 461
Temperature control systems and equipment for heating plants, industrial processes and water heating.
Representatives:—Thomas H. Wilkins, W. F. Meyer, O. Snediker, F. E. P. Klages, E. W. Rietz, W. P. McFarland, J. Pederson, L. O. Weldy.

POWER SPECIALTY CO. Booths 162-5
Foster water-cooled furnace wall, water back for stoker fired furnaces, superheaters in various constructions, header with extruded nozzle, complete Aero pulverizer and details of construction of the various equipment.
Representatives:—Thomas Wilkins, K. H. Bedell, Arno Dietze, R. G. Greenman, T. Hart, W. F. Meyer, J. K. Seabright, W. E. Burks.

HENRY PRATT CO. Booths 38-9
Expansion joints for connections between turbines and condensers, Phillips coal spout swinger and Pratt coal valve.
Representatives:—W. S. Smith, president; S. B. Smith, W. H. Phillips, E. J. Klika.

PUBLIC SERVICE CO. NORTHERN ILL. Booths 314-15
QUIGLEY FURNACE SPECIALTIES CO., INC. Booths 192-3
High temperature cements, baffle construction, use of refractory gun, triple-A solutions for protection of metal and cement from corrosion.
Representatives:—D. F. McMahon, H. M. Thompson.

RACINE TOOL & MACHINE CO. Booth 186
Shear cut saw for high speed metal cutting and duplex band saw machine.
Representatives:—M. E. Erskine, president; J. M. Jones, vice-president; William Reinhardt, Ray Fuller.

RAILWAY INDUSTRIAL & ENGR. CO. Booths 304-5
Outdoor sub-station equipment, disconnect switches, air break switches and indoor switching equipment.
Representative:—E. D. Robertson.

RAMSAY CHAIN CO., INC. Booth 152
Roller bearing silent chains and compensating joint chains for taking up wear.
Representatives:—J. H. Ramsey, vice-president; D. I. Wheeler, S. E. Anderson.

RAWLPLUG CO. Booth 181
Drills and plugs for holding lag screws into masonry.
Representatives:—E. W. Le Beau, Chicago; A. L. Zimmerman, assistant sales manager; H. G. Janton, exhibit manager.

RAYMOND BROS. IMPACT PULVERIZER CO. Booth 53

READING STEEL CASTING CO. Booths 132-33
Cast steel fittings and valves, rustless steel trimmed valves, motor operated and ball bearing valves, all conforming to the new A. E. S. C. standard.
Representatives:—R. T. Hatch, general manager of sales; A. W. Taggart, district sales manager; J. P. Ferguson, sales engineer; J. E. Koch, St. Louis representative; H. P. Howland, C. H. Molitor, G. J. Helfrich, Chicago office.

REEVES PULLEY CO. Booth 211
Variable speed transmission in ball bearing, remote control, self contained and automatic control forms.
Representatives:—C. M. Reeves, vice-president; A. E. Shibley, manager Chicago branch; C. B. Mott, manager Detroit branch; C. B. Robinson, F. T. Moore.

REPUBLIC FLOW METERS CO. Booths 58-61
Panel boards for boilers, for steam turbines, for pumping station operation and for gas producer operation and control.
Representatives:—J. D. Cunningham, president; J. M. Spitzglass, vice-president; M. J. Evans, G. D. Conlee, S. C. Vail, J. G. Tigerman, K. B. Roudebush, J. A. Whelan, G. S. Armstrong.

RICHARDSON SCALE CO. Booth 333
Model coal weighing apparatus showing the use of automatic weighing direct to stoker, of weighing from storage to pulverizer and of hand weighing for stoker feed, all in miniature boiler house.
Representatives:—N. C. Webster, J. Instone, H. E. Matson, W. A. Carte.

RIC-WIL CO. Booths 46-8
Underground conduit for steam, hot water and oil piping with sections of actual conduit and underground pipe line construction.
Representatives:—J. M. Stannard, G. W. Clucas, W. H. Evans.

RILEY STOKER CORP. Booths 158-60
Riley Atrita unit pulverizer, Riley stoker, and poppet valve for use with steam-driven Jones stoker.
Representatives:—F. H. Daniels, president; William Pestell, sales manager; Ollison Craig, consulting engineer; R. J. Krieger, advertising manager; L. V. Andrews, pulverized coal engineer; C. L. Smith, district manager, Chicago; G. H. Sanger, Geo. Moyer, Chicago; W. V. McAllister, manager Detroit plant; W. C. Armstrong, G. H. Umphray, Detroit; O. C. Sheldon, district manager, Cincinnati; W. S. Burlingame, Cincinnati.

RISHER FIRE BRICK CO. Booth 42
Line of fire brick, high temperature cements and other refractories and demonstration of stock carried ready for shipment.
Representatives:—H. E. Risher, president and treasurer; H. O. Engstrom, secretary; E. H. Pratt, A. H. Bratlie, R. E. Hahn.

ROLLWAY BEARING CO., INC. Booth 466
Heavy duty roller bearings for radial and thrust use and application to pillow blocks and line shaft bearings.
Representatives:—C. A. Call, sales manager; S. J. Kaiser, Chicago district manager; Samuel Farrell, Youngstown district manager; John Parker, New England district manager.

ROSS HEATER & MFG. CO. Booth 437
Crosshead guided expansion joints, model of vertical vapor condenser and three-stage Airjector unit.
Representative:—S. C. Ross, president; H. W. Graham, chief engineer; J. W. Spencer, Jr., Burham, Bland & Lindsey, Inc.

ROWAN CONTROLLER CO. Booth 324
Complete line of automatic motor starters.
Representative:—J. S. Rowan.

ROXANA PETROLEUM CORP. Booth 307

SAFETY AUTOMATIC WRENCH Booth 216

SARCO CO., INC. Booth 10
Thermostatic steam traps, temperature regulators and strainers, heating specialties for vacuum vapor and pressure heating systems.
Representatives:—George B. Burke, vice-president; O. George Jenner, John H. Ford.

SAUERMAN BROS. Booths 17-18
Operating model of power drag scrapers and moving pictures of scraper installations for large tonnages.
Representatives:—G. R. Moore, D. D. Guilfoil, H. A. Roe.

SCHUTTE & KOERTING CO. Booths 170-1
Special valves, multi-jet condensers, oil coolers and generator air coolers, indicators, geared pumps, Radiafin tube heaters, piston valves and other specialties.
Representatives:—A. C. Nell, Chicago branch manager; G. Heinemann, engineering department, Edward O'Brien, St. Louis.

THE S-C. REGULATOR MFG. CO. Booth 35
Feed water regulators, pump governors, master control for standard pressures up to 400 lb. and for high pressure service from 400 to 600 lb.
Representatives:—J. M. Barrett, secretary and general manager; C. W. Foster, E. H. Bolton.

SCULLY STEEL & IRON CO. Booth 40
Everlasting blow-off valves.

THE SHARPLES SPECIALTY CO. Booth 109
Portable super centrifuge for purification of transformer, turbine and lubricating oils, also stationary centrifuge, electric motor driven and cross section model to show the method of construction and operation.
Representatives:—H. H. LaMent, vice-president and sales manager; N. J. Hooper, W. R. Prosch, C. H. Wible, H. P. Wilkinson, Chicago office.

S. K. F. INDUSTRIES, INC. Booth 416
Ball bearings for industrial machinery and application to shafting operation.
Representatives:—J. B. Castino, H. A. Gumm, P. A. Carlson, W. B. Pusy, A. Alven, H. R. Clark, R. C. Byler.

SKIDMORE CORP. Booth 23½
Vacuum pumps for condensing and heating systems.
Representatives:—B. Skidmore, Jr., F. H. Sprague.

M. B. SKINNER CO. Booth 191
Pipe clamps, service clamps, flange clamps and reseating tools demonstrated and in operation.
Representatives:—M. B. Skinner, president; K. G. Merrill, vice-president; F. R. McMurray, sales manager, R. H. Ford.

SMITH GAS ENGINEERING CO. Booth 435

SNAP-ON WRENCH CO. Booth 44
Snap-On wrenches and engineers' and machinists' tools in single and in kit arrangement.
Representatives:—C. W. Edwards, C. H. Tennyson, Stanton Palmer, Joseph Johnson.

STANDARD OIL CO., IND. Booth 167½
Petroleum products, their manufacture, testing and uses.

STANNARD POWER EQUIPMENT CO. Booths 46-51
American Steam Pumps of many different types, also air compressors and sectional models. Underground conduits for steam, hot water and oil; centrifugal pumps, sewage ejectors, low-pressure condensers; feed water heaters and steel tanks; bucket steam traps, oil separators and other equipment.
Representatives:—James M. Stannard, president and treasurer; George W. Clucas, secretary; W. H. Evans, J. J. Hayes, A. O. May, R. L. Sutherland, H. C. Crane.

STERLING ENGINEERING CO. Booth 21
Thermotrol temperature regulators, Sterlco thermostatic radiator traps, Sterlco graduated packless valves.
Representative:—George W. Anders, secretary.

THE STETS CO. Booth 52

STICKLE STEAM SPECIALTIES CO. Booth 51
Bucket steam traps, oil separators and similar equipment.
Representatives:—A. O. May, R. L. Sutherland.

STROM BEARINGS CO. Booth 13
Single and double row radial, angular contact, adapter type and thrust ball bearings with moving exhibits.
Representatives:—M. E. Monk, sales manager; H. N. Parsons, chief engineer; Miss Cora C. Smith, advertising manager; E. P. Schmidt, H. R. Higgins, sales engineers.

THE STRONG-SCOTT MFG. CO. Booth 113½
Unipulvo coal pulverizer of 3000 lb. an hour capacity and sectional cast-iron waste heat coal drier, both in quarter scale size.

Representatives:—A. W. Strong, president; Homer Rank, sales manager; H. G. Lykken, combustion engineer; G. W. Heald, Chicago representative.

B. F. Sturtevant Co. Booths 411-13

Induced draft fan of new design, tubular air heater, flat plate type air heater, type Y economizer, dust collecting system, unit ventilator, unit heater and Sturtevant steam turbine.

Representatives:—F. Herlan, vice-president and general manager; P. C. Ekblom, R. E. Horsefield, F. C. Dawson, power plant apparatus; Tom C. Perkins, C. R. Keep, A. S. Krenz, H. W. Parker, heating and ventilating; F. J. Hamilton, C. S. Foster, industrial drying and dry kilns; A. B. Osgood, gas plant apparatus; O. L. Hall, standard and trade size apparatus.

The Superheater Co. Booths 96-7

Superheater units in service at the Hell Gate station and at the Fordson, formerly River Rouge, plant, showing results of operation at high temperatures and under severe operating conditions.

Representatives:—R. M. Gates, manager, industrial division; Leon H. A. Weaver, publicity manager; B. N. Broido, engineer; R. M. Ostermann, A. H. Charles Dalley, R. S. Cooper, D. S. Carter, W. P. Maslin.

The Swartwout Co. Booth 462

Ventilators and application to boiler room ventilation, separators, float and bucket type steam traps.

Representatives:—L. P. Russon, assistant general sales manager; H. C. Miller, C. L. Shank, G. S. Montgomery.

The Terry Steam Turbine Co. Booths 422-3

Steam turbines in single and multi-stage form, also uses and construction of reduction gears and shaft couplings.

Representatives:—B. H. Wood, publicity manager; R. L. Thomsen, J. J. Somes.

Thomas Flexible Coupling Co. Booth 443

Flexible shaft couplings.

Timken Roller Bearing Co. Booths 414-5

Comprehensive display of Timken bearings, also machine for demonstrating positive alinement of the rollers, without use of end cages.

Representatives:—L. M. Klinedinst, general manager, industrial division; Geo. D. Theewlis, district manager, industrial division; R. P. Kelley, advertising manager; S. M. Weckstein, industrial engineer; Geo. W. Curtis, district manager, industrial division; R. W. Ballentine, district manager, industrial division.

The Trane Co. Booths 326-7

Concealed and visible heat cabinet designed to be used in place of steam or hot water radiators.

Representatives:—William F. Bilyeu, sales manager; P. D. Bennett, manager Chicago office.

Troy Engine & Machine Co. Booth 169

Troy self-oiling steam engines for high pressure and superheat on auxiliary drives and also for small generator drives up to 200 b.hp.

Representative:—J. H. Hopp, Chicago office.

Uehling Instrument Co. Booth 127

Recorder for heat waste in flue gases and combined barometer and vacuum recorder.

Representatives:—Ernest E. Lee, J. L. Higgins, J. L. Mayer, F. E. Oswald, C. J. Schmid.

Unishear Co. Booth 417

Demonstration of the cutting of sheet metal in complicated forms, also of cutting steel plates up to ¼ in. thick.

Representatives:—Ulrich Senidors, president.

U. S. Bureau of Mines Experiment Station Booth 330

Apparatus used, methods of experimenting and results obtained in the investigation of boiler furnace refractories, flow of heat through furnace walls, relation of ash fusibility to clinker formation in coals.

Representatives:—O. P. Hood, chief mechanical engineer; P. Nicholls, fuel engineer; Albert A. Munsch, in charge of exhibit.

Vastine Sales Corp. Booth 151

Furnace fire observer for continuous observation of fire and brick work conditions.

Representatives:—R. P. Vastine, secretary, George M. Vastine, C. H. Samuelson, J. W. Himmelsbach.

Henry Vogt Machine Co. Booths 428-9

Drop forged steel valves and fittings for extra high hydraulic and steam pressures.

Representatives:—W. S. Cannon, W. A. Jackman.

Vulcan Soot Cleaner Co. Booth 438

Soot blower operating heads of special valve and ratchet type; chrome alloy blower elements to give protection against corrosion.

Representatives:—F. W. Linaker, vice-president and general manager; William C. Ihde, sales manager; D. E. Hibner, Jr., Burnham, Bland & Lindsey, Inc.

Walsh & Weidner Boiler Co. Booth 142

Section of 54 in. drum for 425 lb. working pressure, section of joint for 2 7/16 in. plate through rivet line. Vertical forged steel headers for high pressures, model of new design bent tube boiler.

Representatives:—J. T. Roberts, J. M. Mason, R. L. Johnson, L. G. Haller, C. F. Weigel, A. C. Weigel, M. D. Kizer.

Walsh Fire Clay Products Co. Booth 332

Special fire brick and fire clay, and their use for construction work. Standard hanging arch title, boiler tube baffle and bridge wall tile, demonstration of difficult and large shapes.

Representatives:—N. S. C. Walsh, vice-president and general manager; C. W. Parker, vice-president, St. Louis; T. M. Meek, John E. Miller, E. L. Gundlach, Chicago.

Walworth Co. Booths 56-7, 68-9

Sigma steel gate valves and fittings with a line of brass and iron bodied valves for general use. Tests as made of Kewanee unions under water with compressed air.

Representatives:—J. M. Olmstead, F. H. Krahn, H. R. Willard, J. J. Harman, F. W. Duemler, W. H. Weber.

Warren Webster & Co. Booths 207-8

Latest developments in vacuum and modulation systems of steam heating, rapid method for handling condensation and air through steam process apparatus, using steam at pressures up to 100 lb.

Westinghouse Elec. & Mfg. Co. Booths 102-3, 110-11

Single retort underfed stokers, designed to embody advantages evolved from large central station stokers; new Westinghouse turbines of type AMD and HNC.

Weston Electrical Instrument Corp. Booth 309

Portable and switchboard instruments in operation and demonstration of the Weston electric speed indicator.

Representatives:—J. F. Inman, A. Thielke, K. Gray, of the Westburg Engineering Co.

Wheeler Condenser & Engineering Co. Booths 112-14

Model of surface condenser with reversing water flow valve for cleaning; steam jet air pumps, hotwell pumps, expansion joints and a cross sectioned model of a small evaporator.

Representative:—E. R. Goodrich, O. E. Anderson, V. T. Price, R. G. Backus, Mr. Chapin.

C. H. Wheeler Mfg. Co. Booths 80-1

Different types of the Radojet air pump, three-stage pump for extremely high vacuums and two-stage with surface inter and after condenser and float control for inter and after condenser drainage.

Representatives:—C. H. Wheeler, Jr., vice-president and general manager; G. L. Kothny, executive engineer; F. Wheeler, Chicago district manager; J. Dobson, engineer, Philadelphia office.

The Wickes Boiler Co. Booth 454

Full size section of single joint header of cross-drum boiler, lantern slide views of shop operation and actual installations, literature describing the construction and design of the Wickes boilers.

Representatives:—E. B. Wickes, H. E. Aldrich, J. R. Fortune, C. F. Wilson, M. S. Nelson, I. J. Van Kammen, E. A. Dunton.

Williams Patent Crusher & Pulverizer Co. Booth 441

Full sized improved ring crusher, also model showing operation, Little Giant type crusher for reclaiming old fire brick.

Representative:—A. E. Schneider, Chicago office.

Worthington Pump & Machinery Corp. Booths 36-7

Centrifugal and reciprocating pumps, air compressors, water and oil meters and Diesel engines. Special sump fund and 850-lb. centrifugal boiler feed pump.

Representatives:—H. E. Troutman, F. W. Hankins, F. P. Sargeant, E. T. Hayes.

Wright-Austin Co. Booth 439

Wright-Austin bucket trap, "quick change" water gage, "clear view" gage glass protector, "crescent" weighted try-cocks, monel metal whistle valves.

Representatives:—C. Burt Walter, president and manager; H. R. Patterosn, Chicago district manager.

Yarnall-Waring Co. Booths 209-10

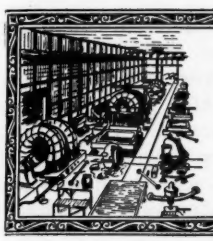
Blow-off valves for all pressures up to 900 lb., V-notch recording liquid meters with hook gage attachment, spray nozzles for aeration of water.

Representatives:—H. J. Moyer, Chicago district manager; G. G. Sutton.

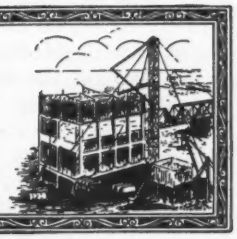
Yeomans Brothers Co. Booths 214-15

Screenless sewage ejector, Shone pneumatic sewage ejector, non-clogging sewage pump, horizontal centrifugal pump for all kinds of general uses.

Representatives:—Charles Yeomans, president; D. W. Burgoon, sales manager; H. L. Bell, P. D. Townsend, E. J. Hull, H. T. Jeffery, sales engineers.



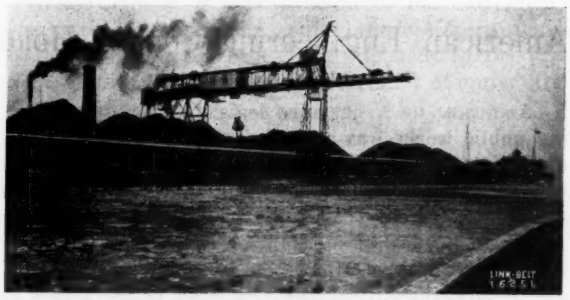
POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS



How Coal Handling Costs May Be Reduced

THE WM. H. PUGH Coal Co. of Racine, Wisconsin, has recently improved its coal handling facilities and materially lowered the handling costs.

During the last few years the amount of coal handled over the Pugh Coal Co. dock had increased to approximately 100,000 t. This tonnage demanded a more economical method of unloading coal from boats to dock and also for reloading the coal from dock for truck or



rail shipments. Furthermore, the problem of screening the coal to prepare the commercial sizes became a matter of increased importance. The dock extends about 1000 ft, upstream from the mouth of the Root River and is 175 ft. wide. A general view of the dock is shown herewith.

For handling the coal onto and off the dock, the bridge tramway method offered the logical solution because, by the use of the bridge, coal can be reclaimed from dock storage and screened; the loading end can be designed to load screened coal, screenings or run of pile to trucks or railroad cars. Also, when screened coal is being prepared from run of pile, the screenings are returned to storage without additional labor; and by means of tramway equipment everything possible is handled by machinery, hence the labor payroll of the dock is reduced to include only two men. Being so generally useful, a minimum of idle time is charged against it.

In order to benefit from lowest freight rates a rope trolley bridge having sufficient capacity to unload an 8000 t. capacity lake boat in less than 24 hr., was made part of the equipment. A brief description of this bridge is as follows:

Type	Rope trolley
Electric current	a.c. 440 v., 3-phase, 60 cycles
Unloading capacity including time for cleanup in tons per hour	350
Maximum unloading capacity tons per hour	500
Size of digging and cleanup buckets in tons	4
Span in feet	140
Length of boom, in feet	65
Rear overhang, in feet	39
Traversing speed, in feet per minute	75
Hoisting speed of bucket, in feet per minute	350
Trolley speed of bucket in feet per minute	1000
Total motor horsepower for boom-hoist, bucket hoist, bucket trolley, screens, screenings, conveyor and traversing machinery	530

Lowered coal handling costs are accomplished with the new equipment because: Coal is now unloaded from boat to dock at ⅕ the former cost per ton, including fixed and operating charges; dock payroll has been cut from 18 men to 3 men; decreased losses from fires in the coal pile have been accomplished; and it has been possible to despatch motor trucks faster.

The engineering and equipping of the dock and bridge was done by the Link-Belt Co.; The General Electric Co. furnished all the electrical equipment and A. F. Gillen & Co., Milwaukee, built the concrete bridge rail foundations.

Two Big Switching Stations Completed in New Jersey

CONSTITUTING one of the larger items in the 1926 program of extensions and betterments of the electric department of the Public Service Electric and Gas Co. was the construction of two big switching stations, one at Trenton and the other at Athenia, near Passaic. Both projects have been practically completed and their combined cost was about $4,000,000.

A switching station is, of course, a plant to which large blocks of power are taken from the generating station and there redistributed to the various substations in the area to be served, from which substations radiate the circuits serving the individual customers. Thus the new Trenton switching station is the northern terminus of a 32-mi. line transmitting current from the Philadelphia Electric Co. to the Public Service territory. This station takes care of the light and power requirements of the rapidly growing industrial and residential territory in and about Trenton. The power is transmitted from Philadelphia to Trenton through wires supported by 200 steel towers ranging in height from 92 to 252 ft. The line runs from Philadelphia northeast through Pennsylvania to a substation at Emilie and thence to Biles Island in the Delaware River near Trenton. Here the line crosses into New Jersey and continues 4 mi. to the switching station.

The Trenton switching station, which will supply various substations in and near Trenton, is equipped

with two banks of transformers, each made up of three single-phase units of 10,000 kv.a. each, giving a present capacity of 60,000 kv.a. The ultimate capacity is expected to be double this.

At Athenia the switching station, similar in construction to that at Trenton, stands on the Newark branch of the Erie Railroad near Van Houten Avenue, Clifton. The initial installation will be 90,000 kv.a. with an ultimate capacity of 180,000 kv.a. The power will be received from the new Kearny generating station, 11 mi. away. The Athenia station will supply Clifton, Van Houten Avenue and Passaic substations, and will furnish power and light for Paterson and surrounding territory, including Passaic, Garfield and Lodi.

At both Trenton and Athenia, large buildings have been provided to house the control, transformer, repair, battery and motor-generator rooms, as well as workshops and offices.

Thirty-Third Annual Convention of the A. S. H. & V. E.

CHARACTERIZED as the first annual meeting of the society west of the Mississippi River, the 33rd annual convention of the American Society of Heating & Ventilating Engineers was held in St. Louis, Mo., January 26 to 28, with a record registration of over 370.

At the present time attention in research is being focused on air infiltration and heat transmission through building walls, proper pipe sizes, temperature, humidity and air motion. Heat transmission experiments are being carried out by means of the heat flow meter, many small thermocouples imbedded in a thin sheet. This meter has been perfected and developed to the point where it is considred a commercial success.

A tentative code for testing direct radiators was adapted and progress reported on work being carried out by the subcommittee on Rating Low Pressure Boilers. Experimental data collected will be put in a usable form at the earliest possible date and made available to members and the engineering public. Under the direction of chairman H. P. Gant, the work of the Research Committee has been put on sound financial basis with practically $40,000 a year available.

During the first professional session Dr. C. W. Brabbee presented additional experimental data to supplement his report of last year, all leading to the conclusion that the radiator should be placed at the point of greatest heat loss from the room. Professor W. H. Severns' paper, "Comparative Tests of Radiator Finishes," showed considerable variation in heat loss with the finish. The maximum effect noted with a radiator subject to both convection and radiation was about 18 per cent instead of the 25 per cent popularly assumed. This comparison is for rusty pipe which gave the highest heat loss, and aluminum paint which gave the lowest.

Chimney design for houses, hotel heating and ventilation and smoke abatement in St. Louis were discussed. Air filters and air conditioning also had a prominent place on the program and were well covered by four papers dealing with design, tests and operation. Professor F. B. Rowley, as chairman of the committee, presented a code for testing filters and M. C. W. Tomlinson went into some detail regarding a motor-driven centrifugal cold air system for dehumidification at low temperatures.

Schoolhouse ventilation was discussed from the standpoint of the engineer, architect and layman, E. S. Hallett concluding this session with some high lights of the newer St. Louis schools where high pressure boilers are used and electric power generated. The modern schools of this city with air washers, recirculation and ozone apparatus show fuel costs as low as 35 cents per pupil, practically half of that for the older school systems in use.

In the last session a great deal of experimental work on the effect of air flow over radiators was presented by L'R. G. Bousquet in his paper, "Turbulence and Heat Transfer."

Pres. W. H. Driscoll, after an unusually successful year, will be succeeded by F. Paul Anderson of the University of Kentucky. A. C. Willard, University of Illinois, Thornton Lewis, Philadelphia, Pa., and S. R. Lewis were elected as first vice president, second vice president, president and chairman of the research committee, respectively. Walter E. Gillham, Kansas City, and A. V. Hutchinson, will continue in their present offices as treasurer and secretary.

American Engineering Council Holds Annual Meeting

ADOPTION OF A DEFINITE legislative program covering public works was a chief event of the two-day annual meeting of the American Engineering Council, which closed in Washington on January 14, 1927, with a dinner at which Charles M. Schwab, president of the American Society of Mechanical Engineers, and Secretary Hoover of the Department of Commerce, delivered notable addresses foreseeing new fields of usefulness for the engineering profession through the Council.

The Assembly of the Council sanctioned a public works measure to be introduced in the House of Representatives by Adam M. Wyant of Pennsylvania. This bill embodies the essential features of the report of the Council's special committee adopted at the last meeting of the Administrative Board held at Cornell University.

The name of the Department of the Interior is changed to the Department of Public Works and Domain and thorough provision is made for the reorganization and more effective co-ordination of the public works functions of the Federal Government.

The Secretary of the Interior would be designated the Secretary of Public Works and Domain. The Wyant bill also provides for an Assistant Secretary and not more than six directors of bureaus of equal rank.

The Secretary may at his discretion establish an advisory commission to be known as the Board of Planning and Design, to be composed of representatives of the architectural and engineering staffs of the Department, to give counsel to the Secretary regarding the design and character of important works to be executed by the Department, and to study and formulate plans for the systematic development of the nation's public works.

The safety and production study, it was reported to the Assembly, is rapidly nearing completion. The manuscript of the study committee's report will be ready for the printers early in March. The scope and

character of the results attained were presented in lectures illustrated by lantern slides at an evening session of the Assembly at the Mayflower Hotel on January 13.

The speakers were L. P. Alford of New York, a member of the committee; J. E. Hannum, director of the study, and L. W. Wallace, executive secretary of the Council.

A. W. Berresford of Detroit, who is chairman of the safety and production committee, and O. H. Koch, representing the Dallas Technical Club, were re-elected vice presidents of the Council. Harrison E. Howe of Washington, representative of the American Institute of Chemical engineers, was again named treasurer. L. W. Wallace continues as executive secretary, and James T. Grady, Columbia University, publicity director. J. H. Finney of Washington heads the finance committee for 1927.

The Administrative Board voted to refer to the president of the Council with power to appoint a study committee, a resolution authorizing the Council "to investigate the feasibility of developing in some way a program of presentation to the attention of young men of proper aptitude the need for engineering recruits and the opportunities that lie in the engineering profession."

The Council, it was announced, has appointed a committee to study the radio broadcasting situation. Calvert Townley of New York, assistant to the president of the Westinghouse Electric and Manufacturing Co., is chairman.

New District Heating Plant for Philadelphia

CONSTRUCTION has recently been started on the new steam heating plant for the district heating system of the Philadelphia Electric Co., Philadelphia, Pa. The plant will ultimately house six 1100-hp. B. & W. cross-drum boilers. The present installation will consist of three boilers with superheaters and Bailey walls in the sides and rear of the furnace. These boilers are designed to operate at 200 lb. gage and will deliver 125,000 lb. of steam an hour at a rating of 368 per cent with the superheat at about 65 deg. F. Provision has been made to permit the installation of air preheaters at some future date if found desirable.

Three Taylor underfeed stokers are at present being installed, burning bituminous coal having an approximate heat value of 13,800 B.t.u. Each boiler will have one forced and one induced draft fan which will be driven by steam turbines. Boiler feed water will be taken directly from the city mains and passed through a zeolite water softener from which it will be delivered to three large concrete reservoirs in the basement of the building. There will be one steam and three motor driven city water pumps in the final installation. The steam driven city water pump will be so arranged that it can be used for fire service when needed. These pumps take the water from the storage tanks and deliver it to two head tanks. Water flows by gravity from the head tanks to two Cochrane deaerating heaters, either of which is large enough to take care of the maximum water required for the completed plant. Feed water temperature will vary between 160 deg. and 212 deg. F. Three steam-driven boiler feed pumps of 750 g.p.m. capacity each will be installed at present, whereas the final installation will consist of four steam-driven pumps.

Steam will leave the station at about 175 lb. gage pressure through three main distributing headers, one of which is being installed for the present installation.

Death of A. W. Burchard, General Electric Official

ANSON WOOD BURCHARD, vice chairman of the board of directors and chairman of the executive committee of the General Electric Co. and chairman of the board of directors of the International General Electric Co., died Saturday afternoon, January 22, 1927, of acute indigestion at the home of Mortimer L. Schiff, with whom he was lunching, in New York City.

Mr. Burchard was born in Hoosick Falls, N. Y., on April 21, 1865. He was graduated from Stevens Institute of Technology in 1885 with the degree of mechanical engineer. In 1902 he joined the General Electric Co. and until 1904 was comptroller. In 1904 he was named assistant to the president, in 1912 he was elected a vice president, and in 1917 was elected a member of the board of directors. In May, 1922, he was elected vice chairman of the board, and in June of the same year, president and chairman of the board of directors of the International General Electric Co. About a year ago he was relieved of the duties of president, but continued as chairman of the board. He was director of several utility and electrical companies, and a member of many electrical and power clubs and organizations.

Venice Plant Will Be Standby for Cahokia

SUBJECT TO THE APPROVAL of the Illinois Commerce Commission, the Union Electric Light and Power Co. of Illinois announces the purchase of the 30,000-kw. Venice, Ill., plant of the Illinois Power and Light Co. for $4,125,000. This will give the combined system of the Union Electric Light and Power Co. of Illinois and Union Electric Light and Power Co. of Missouri, both subsidiaries of the North American Co., four plants in the same district, tied together in a single system—Cahokia, Ashley St., Keokuk and Venice. In anticipation of the purchase, a new steel tower transmission line between Venice and Cahokia has been started. The completed cost will be in the neighborhood of $1,000,000 and will allow the Venice plant to be used as a standby, with the base load carried by Cahokia.

Construction Work of Standard Gas & Electric Co.

INSTALLATION OF an additional 25,000-kv.a. steam turbo-generator in the Harrah plant of the Oklahoma Gas and Electric Co., has been completed, according to an announcement by H. W. Fuller, vice-president of the Byllesby Engineering and Management Corp., in charge of engineering and construction. Referring to progress at the operated properties of Standard Gas and Electric Company, Mr. Fuller added, "Outstanding projects completed during the year include the Bayside plant of the Wisconsin Public Service Corp. at Green

Bay, work on which was started in March. This plant was put on the line on December 20.

"The new circulating tunnels for Station B at San Diego, completed in November, called for some intensive engineering study and real skill on the part of the construction superintendent. An 18,750-kv.a. turbo-generator was installed in Station B during the year. An 1100-hp. boiler with water walls, installed during the year, is already in service.

"Work on the hydro-electric plant of the Louisville Hydro-Electric Company at Louisville and on the government dam has been hastened as much as possible with the unprecedented flow of the Ohio River. The hydro-electric plant is some 60 days or so ahead of the schedule, but the dam is almost the same amount behind."

G. E. to Build Large High-Pressure Turbines

ACCORDING TO a recent announcement from the General Electric Co., a new record for high-pressure steam turbines will be attained in a 10,000-kw., 1200-lb. turbo-generator which the company is making for installation in the Edgar plant of the Edison Electric Illuminating Co. of Boston. This company, it will be remembered, was the first to operate a turbine under a steam pressure of 1200 lb. The original unit was a 3000-kw., 3600-r.p.m., 20-stage turbine and was installed in 1925. This unit has operated so satisfactorily that they have now decided to install a 10,000-kw. unit operating under the same pressure. Besides the 3000-kw. unit operating at Edgar, only one other turbo-generator of this pressure has been made. This is the 7000-kw. G. E. unit in service in the station of the Milwaukee Electric Railway and Light Co., at Milwaukee, Wis.

News Notes

UNDER THE AUSPICES of the Oil Power National Conference, Oil Power Week will be held April 18 to 23, 1927. An interesting program of papers and discussions has been planned and, as noted in the February 1 issue of Power Plant Engineering, a cash prize of $100 accompanied by a certificate, known as The Rudolph Diesel Award, will be made for the best contribution toward the advancement of oil engines. Manuscripts should be in the hands of the National Committee not later than June 1, 1927, and the award will be announced on or before August 1. All communications regarding this competition or regarding Oil Power Week should be addressed to Edgar J. Kates, Chairman National Committee, 29 West 39th Street, New York City.

APPOINTMENT OF James A. Davies as general superintendent of the South Philadelphia Works of the Westinghouse Electric and Manufacturing Co. was recently announced by H. T. Herr, vice president in charge of operations. Alfred Voysey was appointed to the position of assistant general superintendent formerly held by Mr. Davies, and James Lyons succeeds Mr. Voysey in the production department. Mr. Davies has been a member of the Westinghouse organization for more than 17 yr., working his way up from a position in the designing department. He was born at Brighton, England, and studied engineering at the Northern Polytechnic Institute in London. He has served as draftsman on steam engine and turbine work with the J. I. Thornycroft & Co., Humphreys Tennant Co. and J. S. White & Co.

ANNOUNCEMENT WAS recently made that on and after January 11, 1927, the business of the former I. P. Morris Department of The William Cramp & Sons Ship and Engine Building Co., will be carried on by the I. P. Morris Corp., incorporated in Delaware, which has taken over the entire personnel, plant, assets and patent rights of the former I. P. Morris Department. The head office and works of the I. P. Morris Corp. will be at Richmond and Norris Streets, Philadelphia, Pa., and the New York office is at 100 Broadway.

MAGNOLIA METAL CO. announces the removal of its New York office to the New York Evening Post Building at 75 West Street, New York City.

R. H. BAKER CO., INC., Cambridge, Mass., announces the opening of a district office in the General Motors Building, Detroit, Michigan.

QUIGLEY FURNACE SPECIALTIES CO., New York City, has appointed George A. Russ to its service staff, covering the Central South and South Atlantic states.

O. C. KECKLEY CO., CHICAGO, announces that it is now manufacturing its water gages with patented stuffing-box with gland and swing bolts of forged steel, designed for the high boiler pressures and temperatures now being used in many power plants.

J. ROBERT FORTUNE has resigned as district sales manager for the Heine Boiler Co. to become general sales manager for the Wickes Boiler Co., Saginaw, Mich., with headquarters in the General Motors Building, Detroit, Michigan.

BOTFIELD REFRACTORIES CO., Philadelphia, Pa., has appointed the following companies as distributors of Adamant fire brick cement: Southern Steel and Cement Co., Asheville, North Carolina; Henry A. Petter Supply Co., Paducah, Kentucky; Columbia Supply Co., Columbia, S. C., and Spartanburg Mill Supply Co., Spartanburg, S. C.

WORTHINGTON PUMP AND MACHINERY CORP. announces that it has purchased the Harris Air Pump Co. of Indianapolis, Indiana, manufacturers of air lift systems and air lift pumps. This acquisition enables Worthington Pump and Machinery Corp. to offer complete well equipment, including compressors, produced in its own plants.

THE PICKERING GOVERNOR CO., Portland, Conn., has recently brought out a refinement on the Pickering Force Feed Oil Pump, which in no way changes the basic principle on which it is constructed. This oil pump heretofore has had an open ratchet and pawl drive, and the improvement consists in completely housing this drive, thus preventing premature wear and insuring longer service and durability.

ONE OF THE outstanding reorganizations of the year, according to a recent announcement, is that of the Williamsport Wire Rope Co. of Williamsport, Pa. With the purchase of the Cochran interests by a syndicate headed by Robert Gilmore, Edgar Munson, Logan Cunningham and C. M. Ballard, the control of this impor-

tant industry virtually passes into the hands of old employees, who immediately began the building of what is expected to be the biggest wire rope plant in America. The new organization, while introducing new capital, will not affect the personnel of the old organization.

THE L. J. WING MFG. CO., New York City, has just put on the market a new forced draft blower, especially designed for small furnaces of the residence type. The blower supplies sufficient forced draft to burn Buckwheat coal in furnaces having 5 or 6 ft. of grate area. It is of the same design as the larger Wing forced draft units. It is designed to be fitted directly into the furnace base without ducts. It has a fully enclosed motor and may be equipped with automatic control.

SOUTHERN CALIFORNIA EDISON CO., Los Angeles, is arranging a fund of $42,000,000 for extensions and improvements in properties during 1927. The expansion program includes power plants, transmission lines and substation work. The company is arranging to begin work at once on its proposed new steam plant at Long Beach, in the vicinity of its present station. The initial capacity of the new plant will be about 125,000-hp., to be extended to about eight times this size.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO. announces that Harry E. Miller has been appointed Works Manager of its Newark plant in recognition of his 37 yr. of service with the company. He entered its employ in 1889 at Pittsburgh and 11 yr. later was made foreman of the Inspection and Tests of ampere and watthour meters at the Newark factory, being promoted through the grades of assistant superintendent, superintendent, assistant works manager, to his present position. He has been responsible for many improvements of design and manufacture of the company's products, particularly in connection with measuring devices. He designed and made effective the synchronous method of calibrating measuring devices which has been in use by the company for many years. It was Mr. Miller, also, who introduced into the Newark works the use of music as an aid to the workers, a plan which has proved successful both in satisfying the workers and increasing production. He has been responsible for much of the progress made by radio station WJZ, located at the Newark works.

AT THE WASHINGTON TERMINAL STATION of the Pennsylvania Railroad Co., Washington, D. C., an installation has recently been made on six 265-hp. B. & W. boilers of the Gray System of Automatic Combustion Control, manufactured by the Automatic Fuel Saving Co., Philadelphia, Pa.

THE INDIANA PUBLIC SERVICE COMMISSION has granted permission for the consolidation of the Indianapolis Light & Heat Co. and the Merchants Heat and Light Co., both operating at Indianapolis. The new company to be known as the Indianapolis Power & Light Corp.

OSCAR E. BULKELEY, superintendent of the electric light and water systems of Lansing, Michigan, died on Tuesday, January 4. He graduated from Knox College in 1905 and then went to Butte, Montana, where he entered the mines of the Anaconda Copper Co. In 1910, he entered the University of Illinois, graduating in civil engineering with the class of 1912, after which he was appointed assistant superintendent of the water department at Rockford, Illinois. In 1920 he was appointed superintendent at Lansing and under his administration many economies were effected in the operation and construction of the various power and heating plants of that city. He was a member of the American Society of Civil Engineers and the American Waterworks Association.

THE OHIO POWER CO., Canton, Ohio, has ordered from the General Electric Co. a 165,000-kw. turbo-generator set to be installed in its Philo plant at Philo, Ohio, which was completely described in the June 1, 1925, issue of Power Plant Engineering and which has since operated with very high economy. The installation of this unit, complete with boilers, housing, coal handling apparatus and electrical equipment, calls for an expenditure of approximately $17,000,000 and will increase the capacity of the Philo plant to 245,000 kw.

THE BROAD RIVER POWER CO., Columbia, S. C., operated by the General Gas and Electric Corp., New York City, has taken over the Blue Ridge Power Co. and will operate two hydro-electric plants on the Green River, N. C., with about 120 mi. of high-tension transmission lines. The system will be tied in with the steam generating plant at Parr Shoals, S. C., which was described in the February, 1927, issue of Power Plant Engineering.

ON THE MORNING of January 18, 1927, the City of Milwaukee opened bids for three 400-hp. horizontal water tube boilers, with stokers, superheaters and auxiliaries, for its Riverside Pumping Station, Milwaukee, Wis.

ORDERS RECEIVED by the General Electric Co. for the year ending December 31, 1926, totaled $327,400,207, an increase of eight per cent, or nearly $25,000,000, over 1925, President Gerard Swope has announced. This is the biggest volume of orders in the company's history, the previous high mark, achieved in 1920, being $318,-470,000. For the fourth quarter of 1926, orders booked amounted to $80,406,570, compared with $78,636,669 for the last quarter in 1926, a gain of two per cent.

AT THE MEETING of January 12, 1927, the Federal Power Commission, Washington, D. C., authorized the issuance of a license and preliminary permit to the West Florida Power Co. for a power project on the Ocklocknee River. This project includes a dam forming a reservoir of 37,000 acre-feet together with a power plant with an installed capacity of 12,000-hp. An application was filed with the commission by the Board of Directors of State Institutions, State of Arizona, for a power project on the Colorado River at the Bridge Canyon site, where it is proposed to construct a dam 825 ft. high, which will create a reservoir having a capacity of 6,238,000 acre-feet. The impounded water would be conveyed through tunnels to a power house below the dam, where it is estimated that 1,300,000 hp. could be developed. An irrigation project is also planned in connection with this proposal. The Board has also applied for a permit for a power project near Glen Canyon site on the Colorado and San Juan Rivers, Arizona, proposing to build a dam 693 ft. high to impound 50,501,260 acre-feet of water, this project also including a power plant.

Books and Catalogs

THEORY OF WATER HAMMER by Lorenzo Allievi; 2 pamphlets each 7½ by 10½ in., 130 pages, 64 diagrams; Rome, 1925; translated by Eugene E. Halmos; distributed through A.S.M.E., 29 West 39th street, New York.

One of the few authoritative statements on the complicated subject of water hammer is that prepared by the Italian engineer, Lorenzo Allievi, after a lifetime of study devoted to the subject. Not wishing to use the paths broken by his predecessors, the author takes up the problem at its origin. The first work of this kind published in English, by N. R. Gibson, presented results identical with Allievi's, but worked out independently.

This discussion, although extremely technical, should be of great interest to all engineers, whether designers or operators, since the problem of water hammer arises in so many different ways. The assembling of all diagrams in a volume separate from the text is not, of course, in accordance with the usual American practice and has some disadvantages.

The discussion is in the form of notes commenting on and applying the principles laid down by the author in 1902. He discusses first the fundamental mathematical equations and develops a circular diagram system that proves most useful in the investigation of water hammer phenomena. Water hammer in closing and opening are then analyzed by these methods. Following this is an analysis of counterblow: first, following complete closure, second, following opening. Note V discusses the phenomena of resonance set up in a conduit by rhythmical impulses caused by rhythmical closing and opening operations or by progressive closing or opening operations executed in rhythmical steps. Such impulses may cause the pressures, because of the amplitude of successive variations, to reach values greater than those caused by ordinary continuous opening and closing.

STEPHENS-ADAMSON MFG. CO. is issuing its new general catalog No. 30, which contains a complete scheduling of the material-handling machinery designed and manufactured by this company.

The descriptions give concise information relating to each unit. The blue prints and drawings show typical arrangements and important dimensions. The tables include specifications, sizes and prices necessary for selecting and for purchasing. There are also listed those specialties manufactured by the company's engineers which are related to production of material-handling equipment. Tables give new data referring to the design, capacities and power requirements of all classes of conveying and elevating machinery.

There are 960 pages of carefully compiled and correlated listings of machinery units, over a thousand illustrations and nearly a thousand blue prints and drawings. Lightweight paper to conserve bulk and semi-flexible binding lend to convenient handling.

Requests for copies of this catalog are now being received by the Advertising Department of the Stephens-Adamson Mfg. Co., Aurora, Ill.

COFFIN VALVE CO., Neponset, Mass., in general catalog No. 4-B, describes its Kelty motor drive unit. This unit is a complete mechanism for operating valves, consisting of motor and electrical equipment, together with reduction gears, stem nut, ball races, enclosing case, ready to bolt to the yoke of a valve. It attaches to the regular valve stem and can be applied to old valves in the line as well as to new valves. It has a multiple disk clutch and a centrifugal limit switch and the thrust of the clutch is taken by two Timken roller bearings. Complete push button control with indicators is provided.

In section 3-A of the catalog this company describes the Dow disk arm pivot valve used as a check valve in pump discharge lines. This valve is operated by a hydraulic cylinder controlled by a solenoid and is designed so that water hammer will not be produced on closing.

THE ALLEN-SHERMAN-HOFF CO., Philadelphia, Pa., has issued a new bulletin describing its hydrojet ash-sluicing system. This bulletin shows the various features of the construction, such as the cast-iron ash hoppers, the method of feeding ash over the feed plates into the horizontal sluice and other details. Discussion is given of its application to stoker-fired furnaces, pulverized fuel fired boilers, air and water-cooled furnace bottoms, with many illustrations of actual installations.

GENERAL ELECTRIC CO. in bulletin GEA-578, describes mechanical drive turbines type D. These are of the impulse type, pressure compounded when arranged with more than one stage and velocity compounded in each stage by using two rows of buckets. They are designed with large clearances and are applied to all types of mechanical drives. They can be operated either condensing or non-condensing. They are supplied in sizes from 5 to 700 hp. for speeds from 1000 to 5000 r.p.m. and for all ordinary steam conditions.

BUFFALO FORGE CO., Buffalo, N. Y., in a new bulletin describes the Buffalo cinder-eliminating fan. This has a rotor of the Conoidal type with a special construction of the scroll case to entrap solid matter in the gas. It has the same fan characteristics as other Buffalo forced and induced draft fans and one test showed that it removed approximately 95 per cent of the total solids in the gas.

THE KORFUND CO., INC., New York, in a recent bulletin describes the Korfund Vibro damper designed to deaden vibrations of machinery. This is built in five sizes to sustain loads from 40 to 4000 lb. and consists of a spring type of support with insulating material between it and the baseplate and housing of the apparatus.

A. C. NIELSEN CO., Chicago, Ill., has just issued a special survey covering economy of Reeves transmission for driving assembly conveyors used by the Hupp Motor Car Corp. This survey gives cost and operating data of the Reeves transmission as compared with other types of drives applied to the same service.

COMMITTEE ON PUBLIC RELATIONS of the Eastern Railroads, 143 Liberty St., New York City, is distributing its 1927 wall calendar which illustrates how the gross revenue of a railroad is distributed in wages, fuel and other material expenses, taxes, interest, dividends, etc.

IN A 4-PAGE folder just issued, The Brown Instrument Co., Philadelphia, Pa., discusses and illustrates the use of recorders in the power plant, showing how they give the facts about all phases of power plant performance.